AMERICAN MACHINIST

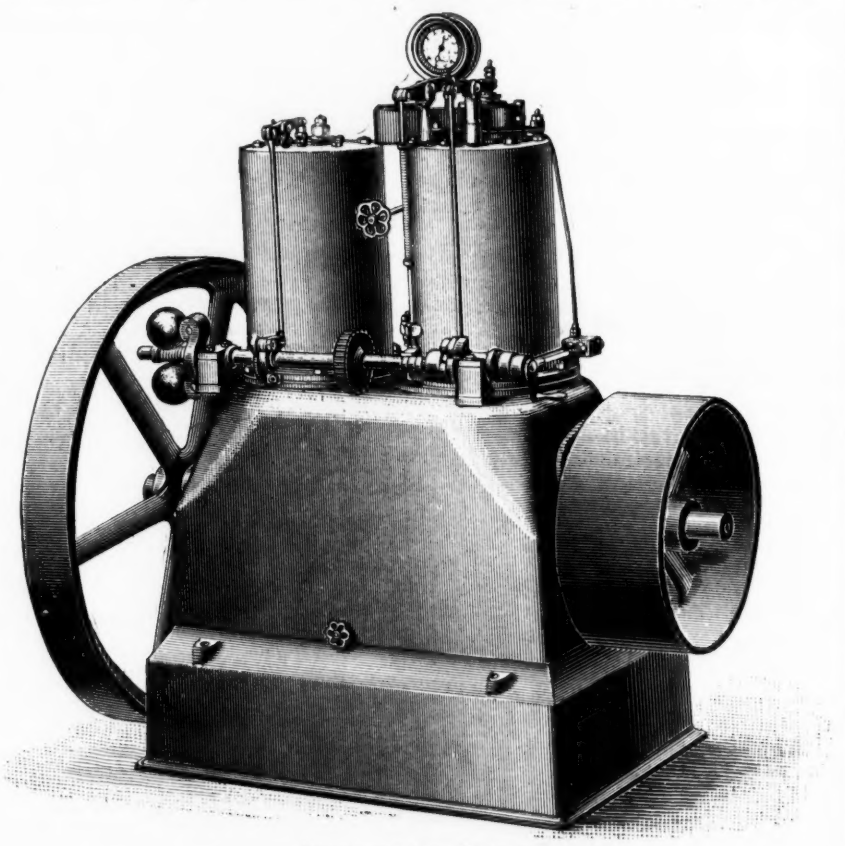
A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 10, No. 37 WEEKLY. | NEW YORK, SEPTEMBER 10, 1887. | $2.50 per Annum. SINGLE COPIES, 5 CENTS.

COPYRIGHT 1887, BY AMERICAN MACHINIST PUBLISHING COMPANY. For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Richards' Oil Engine.

The illustration represents one of the Richards oil engines, which are now manufactured and introduced by the Adams & Richards Machine Company, New Brunswick, N. J. The design of these engines is very simple, compact, and of good proportions. All the working parts are easily accessible, so that they can be kept in good working order and well lubricated, rendering these engines very durable. The motive power for these engines is obtained by the use of crude petroleum or kerosene oil and compressed air. Boilers of any kind are not used. One of the cylinders shown in the illustration is called the working cylinder, and the other cylinder is a common air compressor, which is correctly proportioned for the amount of work the engine has to do. The head of the working cylinder is provided with an induction valve, and also with an exhaust valve; the former admits the compressed air into a chamber called the vaporizing chamber. Into the same chamber is forced by means of a very small pump the oil which is taken from a barrel or tank placed wherever it is convenient or where room can be found for it. In this vaporizing chamber the air and oil is thoroughly mixed, so that the oil becomes vaporized, the two forming a kind of gas. From the vaporizing chamber the gas is admitted into another small chamber called the combustion chamber. This combustion chamber is situated directly under the vaporizing chamber, and also forms part of the clearance space between the piston and the cylinder head. In this combustion chamber the gas or mixture of air and oil is ignited at the beginning of every forward stroke by a small flame which is constantly burning while the engine is running. By this arrangement no sudden explosions occur, thereby preventing sudden and hurtful shocks on the working parts of the engine. When the ignited gas or vapor gives motion to the piston it has six expansions. and is then allowed to escape through the exhaust valve. The exhaust vapor as it flows out of the exhaust pipe is invisible, thus clearly showing that the combustion of the oil has been perfect, and it may be remarked that this perfect combustion has been caused by the thorough vaporization of the oil in the vaporizer. Of course advantages are gained by this perfect combustion of oil, but the greatest advantage gained, and which will be appreciated by all persons who use these engines, is that a residuum cannot be formed, and, therefore, the working cylinder is always kept clean. Another important advantage gained is the economy in the amount of oil used; it is claimed that for one horse-power one-fifth of a gallon of crude petroleum or kerosene per hour is sufficient. The working cylinder and the mechanism to which it is connected are similar in design to those of an ordinary simple crank steam engine, with the exception of the valve gear. The induction valve and the exhaust valve in the cylinder head are poppet valves, the valve gear being arranged in a manner which will enable the governor to control and regulate the correct supply of oil and air to the vaporizer, thus making the engine automatic while running, and requiring no attention after the engine has been started. The starting of the engine is also a very simple matter; all that is necessary is to ignite the vapor or gas in the combustion chamber with an ordinary match, in a manner similar to that of igniting the gas in any dwelling, and thereby starting the engine immediately. Starting the engine at the commencement of a day's work gives no trouble, and scarcely requires any time. In order to prevent the working cylinder and valve chambers from becoming too hot, they are surrounded by a jacket, through which cold water is kept in constant circulation. The air compressor is worked directly from the crank-shaft, and does not require a separate engine.



RICHARDS' OIL ENGINE.

These engines are suitable for many purposes; and, since boilers, chimneys, etc., are not used, they recommend themselves to establishments in which cleanliness is of the first importance. They are extremely well adapted for private dwellings, for illuminating purposes, or any other places where boilers are objectionable or cannot be used. These engines are also well adapted for districts where the water supply is limited or scarce.

Mr. Geo. M. Richards has devoted all his energy, time and skill during eleven years to the perfection of this engine. The Adams & Richards Machine Company have strong confidence in the result of their labors, and believe that the design of this engine is now as perfect as it can be made. They are now prepared to furnish any size up to fifty horse-power. Eighteen of these engines are at present used in New York city and vicinity, and, it is said, give excellent satisfaction.

By the provisions of a bill introduced into the English House of Commons, the local authorities are permitted to levy taxes for the establishment of technical schools.

Drilling Holes.

BY FRED J. MILLER.

The precise location and drilling or boring of holes is no mean part of the machinists' business, and indeed upon some certain kinds of work, requires more of care and skill than any other part of the job, however good the lathe and planer work may need to be.

In many shops the drill presses are regularly abused, and even if good ones are bought they are by this abuse soon rendered unfit for good work.

If a drill press comes into the shop which is intended for use on fine work, and is so designed and built as to fit it for such work, it should in the first place be provided with a center fitted to its spindle and turned true in its place the same as a lathe center. This being done, it is only necessary to determine and mark the center of any hole which is to be drilled or bored, and then set this center mark directly under the point of the spindle center, fasten the work and proceed. Some such plan should always be adopted where the work is sufficiently heavy to prevent the drill from making its own adjustment, and if it were oftener adopted there would be much less wondering "why that drill didn't go square through."

And whether the work is heavy or not, if a considerable degree of accuracy is required it may be secured by making small center marks, setting the work in position by the spindle center and using a short boring bar for finishing the hole instead of either drilling to size, or drilling and enlarging by the counter bore.

One or the other of two conditions usually governs the location of holes in any piece of work; either they must be placed at some given distance from other holes or working points, this distance being determined by direct linear measurement, or they must duplicate some piece of work already done, regardless of the actual measurement of these distances as expressed in terms of linear measurement.

Of course there are many ways of doing these things—more than can be spoken of within the limits of such an article as this—but it is my purpose to present a few of them.

First taking the case of holes the distance between which, and from other points is to be determined by measurement. The best plan will of course depend upon the character of the work, and the degree of accuracy required. For a large class of work the time-honored process of striking circles from the given center, marking these circles with a center-punch, and then keeping the drill within this circle by "drawing" with the small round chisel, is sufficiently accurate, and indeed some men are met who claim to be able by this method to drill holes sufficiently accurate for any purpose whatever. But it is safe to say that they are either possessed of an extravagant idea of their abilities in this line, which a severe test would soon relieve them of, or they are unacquainted with work which requires the utmost attainable precision, and which in itself affords, when finished, a ready means of testing the degree of accuracy arrived at.

It is extremely difficult to get a drill started exactly right within a scribed circle, even if the circle itself is true, and though it seems simple enough, it is really no easy matter to strike a true circle with dividers which shall be exactly concentric with a given point.

Any one who has some conceit in this matter, may perhaps easily rid himself of it by striking a circle, and then centering the point from which it is struck upon a lathe face plate, by a wobbler, so that the center point is true. Now let him by careful observations determine whether or not the circumscribed circle is true. The chances are that he will find that it is not—thus proving that where considerable accuracy is sought it is better to work from the center mark itself, when it is known to be right.

The method indicated at the beginning of this article will secure very good results, but when possible a bushing should be provided for the boring bar to work through, which may be either above or below the cutter, and be fixed in the table of the drill, or into a bracket fastened to the table, or into an arm fitted to the column of the press, according to circumstances. Both the bracket and the arm should be adjustable for height as well as laterally, and also admit of the use of bushes having different sized holes.

With a press provided with facilities for supporting bushings of any desired size, in any required position, we can be sure that any drill, butt mill, or boring bar may be made to go just where we intend it to go, and a good deal of work may be drilled or bored without being laid off at all, more accurately than it could be laid off and drilled.

As an instance of this, we will suppose the piece of work, Fig. 1 (page 2), to be planed up square and true, and that it is to have the holes *a* and *b* drilled through it, and that it is

desired to make them precisely two inches apart. The arrangement of the work upon the drill table is shown in Fig. 2, in which *c* and *d* are parallel strips clamped to the drill table and just in contact with the work when it is fastened in position to drill the hole *b*, then the bushing either in the bracket or arm being nicely adjusted, and the hole *b* drilled it is easy to drill the hole *a* precisely two inches from it by simply leaving the parallel strips clamped, loosening the work, and moving it to the left, keeping it in contact with the strip *c* until a two inch gauge or a pair of calipers set by the micrometer or vernier just passes between the strip *d* and the end of the work, and again clamp it. The position of the bushing not having been changed, it must be evident that those holes must come nearly two inches apart. Then if several pieces of the same kind are to be drilled, a third parallel may be clamped to the table in contact with the right hand end of the work when in position for drilling hole *a*, and left there; then if the pieces are of uniform length they can be moved from left to right, or the contrary, against the parallels and uniformity easily secured.

Of course many other applications of this principle, with modifications to suit circumstances, will readily suggest themselves to any mechanic who is likely to be engaged upon such work.

The same idea may be carried out in drilling with the lathe, especially where it is provided with a rest to which the work can be fastened and which is adjustable vertically. The milling machine also affords a good opportunity for doing work in this way. If the spindle is fitted with a drill chuck and boring bars, a jig or other piece of work may be clamped to its table, or a plate provided for the purpose, and the movement of the vertical and horizontal slides gauged from one hole to the other, upon the principle indicated, and great accuracy secured.

Where for any reason the work must be laid off and the centers of the holes marked by the center punch, it is practicable to get the holes just true with the center marks by the use of the device, Fig. 3, which consists of a piece of steel *a*, into which are pressed two bushings having holes of any convenient size. These bushings are nicely lapped out and ground true before being pressed into the plate, and twist drills are ground to fit them as closely as practicable. The plugs *b* and *c* are hardened and ground to fit the bushings closely, and at the same time that the cylindrical part is ground the small conical points are also ground quite true.

Now, supposing the holes to be laid off correctly, one of these plugs may be put through its bushing so as to project a little below the plate, and the small point put into the center mark; then holding the plug in that position, the plate is pushed down on to the face of the work and clamped. Then the plug is withdrawn, leaving the bushing exactly centered over the mark. Now the drill may be put in and the hole started, then the plate should be removed to save wear of the bushing and the drilling finished; after which the hole may be enlarged to any desired size by the use of counterbores, which, of course, for such work, should be ground up to size after hardening.

But it frequently happens that a piece of work is brought to the tool maker having holes drilled in it and called a sample or model; and it is required to make a jig which will drill pieces the exact duplicate of it. In this case, of course it is unimportant what the actual measured distance may be from one point to the other, and so a method is employed which ensures exact duplication regardless of actual measurement.

Under such conditions it is the usual practice to design and make the jig complete, with the exception that the holes for the bushings are laid off as nearly as may be, and bored slightly smaller than intended to be when finished. Then the holes in the sample piece are fitted with steel bushings, and the piece placed in position in the jig

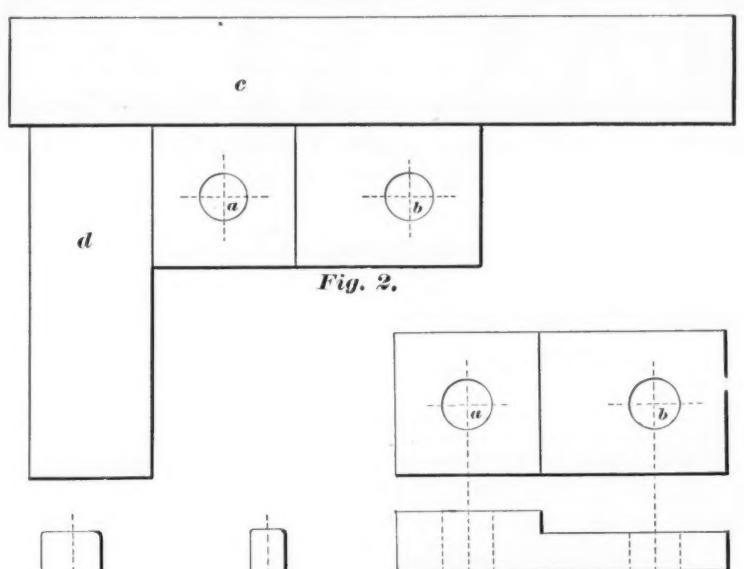


Fig. 2.

Fig. 1.

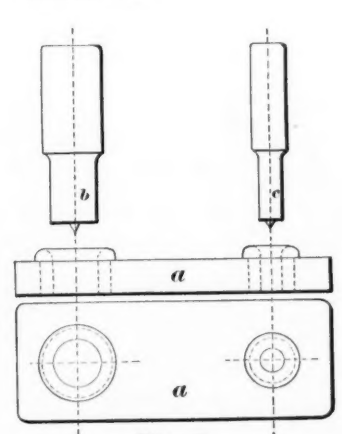


Fig. 3.

Drilling Holes.

and fastened in the same manner as the work is to be. The holes in the jig are then counterbored to full size, using the bushings in the sample piece for the end of the counterbore to run in. Then if the work has been well done, it will be found that when the jig is fitted with bushings it will produce work the exact duplicate of the sample.

Protecting Inventions in Switzerland.

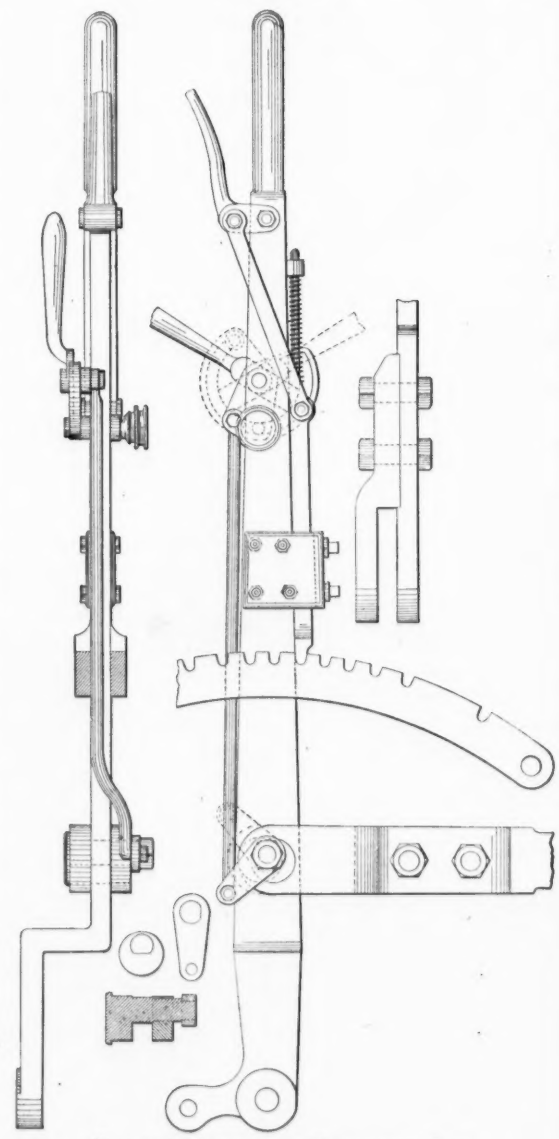
This little republic, which has so long borne the reputation of a pirate in respect to mechanical inventions, has at last made a move to relieve herself of that unsavory record. In the August issue of *La Propriete Industrielle*, the official organ of the International Bureau for the protection of Industrial Property, it is stated that by a popular vote the Swiss people, on July 10, pronounced emphatically in favor of the enactment of a patent law. The change in public sentiment on this subject since 1882 is shown by a comparison of the votes taken at that time with those taken this year; not only is a majority of the popular vote required for such an amendment to the Swiss Constitution, but a vote of a majority of the Cantons. In 1882 two-thirds of the Cantons opposed the amendment and the popular vote was adverse by a majority of 15,000 in a total vote of 300,000. This year the amendment is carried by a majority of 146,000 in a total vote of 260,000, and only the Canton of Uri and the half-Canton of Appenzell in opposition. It is presumed that the law will be enacted without delay.

A special feature of this law will be that according to the terms of the amendment just adopted, the right to a patent is to be restricted to such inventions as are represented by models. This will exclude processes and compositions of matter. It does not seem to be required that the model shall in every case be deposited with the application for patent, but the invention must be one capable of representation by a model, and evidence that such a model has actually been constructed will be necessary.

There is a good deal of wisdom in this requirement. Since the United States Patent Office has ceased to require models it has been overrun with impracticable schemes and wild theoretical conceptions, the futility of which the first serious attempt to construct a working model would have demonstrated. The Swiss government will take a step in the right direction, one in which the United States has led, and from which, by an unwise ruling of an inexperienced commissioner, unfortunately receded a few years ago.—*Tobacco.*

Player's Graduated Expansion Cam.

The reverse lever illustrated in the annexed engraving, appears to be one of the simplest and most effective devices so far brought out for giving the locomotive engineer the means of graduating the point of steam cut-off. Throttling the steam is usually a wasteful practice and is done with locomotives to a great extent because the ordinary reverse lever and widely notched quadrant do not provide the means of regulating admission of steam close enough to meet all the requirements of engine running. In the Player invention the ordinary lever and quadrant are employed, so that no expensive change has to be made to apply the device, but the pin connecting the reach rod to the reverse lever is made cam-shaped, or eccentric, and an attachment is put on for revolving the pin as the engineer desires. As the center of the pin in the lever is not coincident with the center of the part holding the reach rod, revolving the pin has the effect of lengthening or shortening the reach rod. This movement is made sufficient to cover the distance represented by the movement between two notches in the quadrant. If the engine is running along in say the 9-inch notch, and is lagging a little, but not enough to require the increased valve travel that the next notch would give, the ordinary practice is to advance the lever and partly close the throttle, thereby losing to a great extent the advantage of using high pressure steam. With engines having this attachment on, the lever operating the cam is moved and the links dropped to the point where the engine will handle the train easily, which may be any point between 9 and 12 inches, and no throttling is required. The arrangement is equivalent to giving the fine movement of a screw reverse gear without having the disadvantages of the screw. The device, which is patented, was invented by John Player, Master Mechanic, Central Iowa Ry., Marshalltown. The improvement has been applied to a great many engines, and, we are informed, works admirably.



Player's Graduated Expansion Cam

Need of Special Tools for Making Standard Machinery.

By W. H. Hoffman.

THIRD PAPER.

As I have endeavored to show the great advantages of complete special machines for standard work, I will now consider the matter of special fixtures and appliances to be used in connection with the ordinary machine tools, such as lathes, upright and horizontal drilling machines, boring mills, etc. The value of a special fixture for manipulating the details (small parts usually) of standard machinery, lies wholly in its design, as it, if possible, must be made with a view to the greatest simplicity in application, and there should be no mutilation of the tool to which the fixture is to be attached.

Radial and other drilling machines can be arranged to do work other than drilling, boring and facing, as the rotary cutter can be used on them in various forms, and nearly all of them can be easily fitted with a backing motion for machine tapping. The radial drill in particular, with its usual wide range of the drilling head, and with its liberal amount of metal, is well adapted to receive its full share of special fixtures. Any good radial drilling machine can have its table arranged to receive a chuck for holding curved pieces, such as links for steam engines, and other segmental pieces, provided the radius of curvature is within the reach of the machine, and a rotary cutter working in connection with a radial feed on the reach arm will do good work. It will be seen that the short and long sides of a link can be accurately finished by simply moving the drilling head to or from the center of the upright post. The feed worm sector can be of any radius suitable in length to give proper feeding power against the cut, while the worm and its bearings can be attached to the table in a very substantial manner. The radial drill is also easily adapted to accurate machine tapping up to very large sizes, and for straight face and edge milling it is an excellent tool; the only extra appliance necessary for this work is the backing motion, and a horizontal feed for the drilling head.

The horizontal boring and drilling machine in its regular routine of work is a very useful one, and the special uses to which it can be adapted are numerous, yet as a rule these are passed by in the machine shop. As a heavy milling machine, or when used for rotary or continuous cutting, the horizontal boring tool is one of the best, where the length of the work is within the reach of the travel of the transverse table. The smallest sizes of these machines, are geared strong enough to drive large milling or rotary cutters, and the table, driving head, and main spindle are in strength beyond the possibility of springing. The feeds are numerous in grades, strong in action, and convenient in handling, while the space on the top table is generally ample in surface to receive any kind of device for holding special work. As in the case of the radial and ordinary upright drills, the horizontal machine can be used for heavy machine tapping with small additional expense. Special face milling and side cutting can be done on the horizontal borer with cutters larger than those now used on the very largest special milling machines, while the adjustments in a vertical line to receive work are far beyond the capacity of these machines.

The upright turning and boring mill is another machine to which can be attached several useful fixtures and special cutting tools. First of all, I must mention one defect in nearly all the types of vertical boring and turning mills, and any master mechanic or foreman who has pulleys to turn (with very wide faces) say from 24 to 60 inches, will, I think, agree with me in this criticism. The fault is in the universal practice of making both boring and turning spindles or stakes of the same diameter, and I will illustrate by a rough sketch the action of the ordinary standard turning and boring mill, while finishing a pulley, say 12 feet in diameter and 50 inches face.

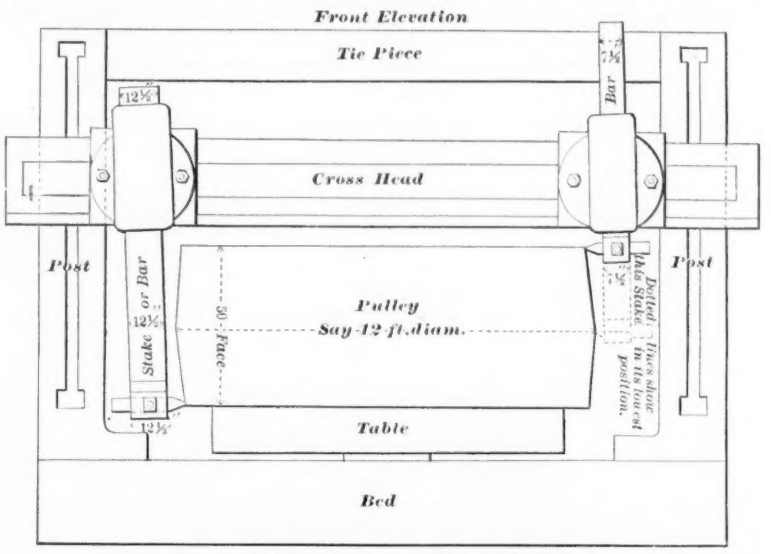
It will be readily seen that one stake must reach to the lower edge of the pulley, increasing the leverage to such an extent that the ordinary stake is altogether too weak for its work. To obviate this difficulty one stake or spindle should be small, say from 7½ to 8 inches in diameter, so that it can pass down through the center hub of a pulley when boring a long hole, but the other stake can be of any convenient size, and should be as large as possible, say 12½ inches in diameter, as it must reach well down on the outside of the pulley rim or any similar piece of work. The trouble with the two small stakes is, of course, that one of them is entirely unfit for the service required of it, for the cut must be very much reduced at this spindle to prevent excessive chattering, and all sorts of bracing is resorted to to prevent the springing of the spindle and head; but very few of these devices are effectual. A mill built something like the accompanying sketch will overcome all the difficulties in heavy cutting.

There is a machine of very large capacity, similar in construction to that shown in sketch, at the works of the Bethlehem Iron Company, and it has always been a success. I think it swings about 18 feet, and the stakes are about 9 and 14 inches respectively.

Starting, then, with a machine of this character, with the stakes arranged as described, we find that a large variety of turning can be accomplished, such as cutting spiral grooves on large hoisting drums and straight grooves for rope pulleys.

I do not exactly like the idea of using one of the stakes as a slotting bar, but I do believe in fitting a rotary cutter or milling tool on the end of one of the stakes which can be well driven by a shaft passing through the stake, and thus mill out keyseats in pulleys, drums, propellers and like pieces.

I have mentioned only the principal tools generally used in a machine shop, as the ones best suited to receive extra attachments and work; but every experienced mechanic knows that there are many other machine tools that can be used in producing rapidly special standard machinery; and in inventing special fixtures the foreman will find a wide field to work in. If he adopts this system in all its practical forms, he will soon see that he has few idle tools in his shop, as each machine will be in operation most of the time, either on its regular work or on special cuts.



Boring Mill Stakes for Heavy Turning.

In puttting up any machine shop, the system of light overhead tracks, with branches leading from the main track to each tool, should always be used. These tracks are now made automatic in action, so that when the operative starts to hoist a piece from the machine with the chain block, the switch branch at the machine is automatically thrown in connection with the main track, at the same time leaving the track clear to other points in the works. On these tracks can be handled the special fixtures, without damage to them or the tools to which they are fitted. I cannot see how anyone just starting in the machine business can afford to ignore the rapid cutting system.

Improved Independent Chuck.

The cuts herewith illustrate a line of independent chucks that the E. Horton & Son Company, Windsor Locks, Conn., have lately added to their large list of universal and combination chucks. It is designed to meet the requirements of those who have a great variety of work to perform, and who want a strong, durable and cheap independent jaw chuck.

Fig. 1 is a face view of all sizes, 16″ diameter and less; Fig. 2 is the same view of all over 16″ diameter; and Fig. 3 is a sectional view, showing mode of construction and operation. These chucks are very strong, and larger sizes have slots through the face, so they can be used for lathe-face plates, if desired, by taking out the jaws. The screws are of steel, and have a long bearing at both ends, the outer end being hardened, after being fitted for the wrench. The jaws are of steel, hardened, and in all sizes; can be run out and reversed, which is a valuable feature in an independent chuck.

Bolts and wrench are furnished with each chuck, the latter being hardened where it comes in contact with the screw.

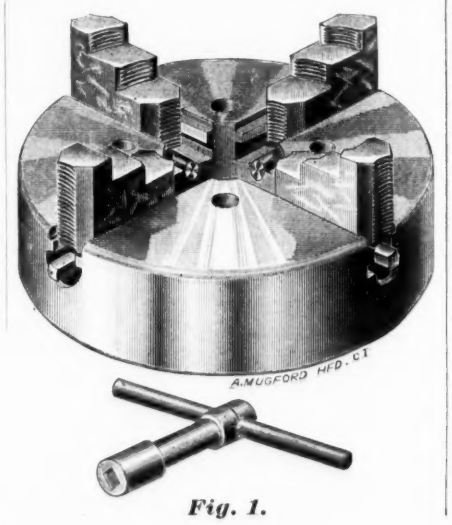


Fig. 1.

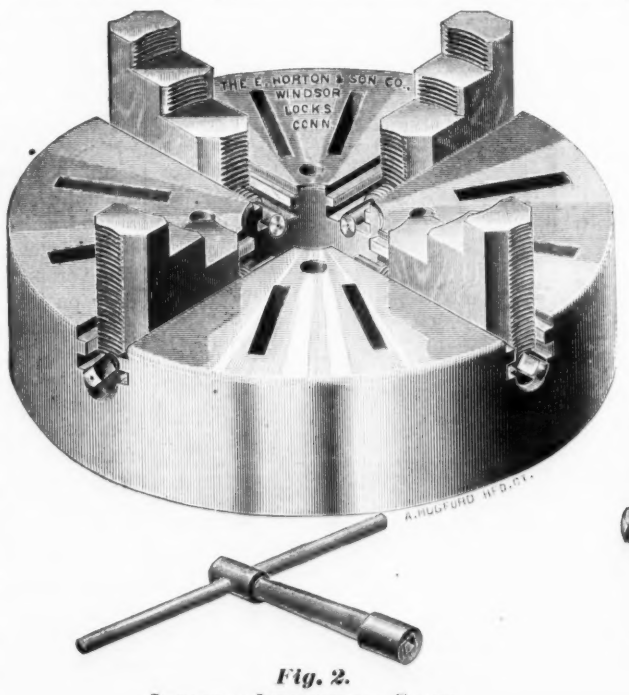


Fig. 2.

Improved Independent Chuck.

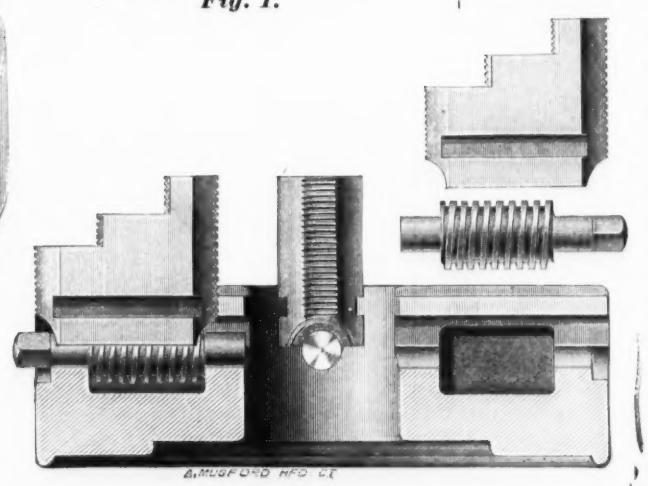


Fig. 3.

The Bangor, Me., *Industrial Journal* well says:

Labor strikes are now few and far between. This fact does not occasion so much remark in the newspapers as the strikes used to do, but it is an indication of a better state of feeling and of business throughout the country.

An inventive genius proposes to make the lower part of all car windows so they cannot be raised. This he thinks would do away with the controversy as to which passenger in the seat should control the window.

The hot summer has been favorable for the builders of ventilating fans.

Tinkering Engineers.

By John A. Hill.

Some time ago I wrote you a description of a model round house foreman I saw in a dream. I knew the engineers would like the tone of the article, but I have observed since that the men who would like it best are the very ones who give the foreman and the shop men the most trouble. They are the chaps who are eternally monkeying with their rods, eccentrics, guides, links, valves, etc., and as this class of engineers is generally the ones who know the least about them, they make them worse than they were before.

I fired for a tinker once, and he had as good an engine as I ever rode on. But he was going to make her better. He made her side rods suit him ten miles from town on her second trip out of the shop, and the round house foreman took them down and filed the pins and re-babbitted them to make them suit the M. M. when he got her in. Next trip he went the first forty miles without saying a word, and I knew he was studying a change. It broke out; he leaned over to me and says: "Johnnie, she's a daisy, ain't she?" "Best on earth," says I. "But she is just a hair off," says he; "listen to her." She was throwing out exhausts $2\frac{3}{4}$ square, and they remained solid cubes till their echoes got back from overhead. I looked at him beseechingly, and hooked the door back a notch so he could hear the corners of the exhausts strike the draft pipe, but he never heard them. At the other end of the road there was no shop and I held a torch for him while he moved her eccentric blades "just a hair." I made a timid suggestion that he had better mark the blades before he moved them so he could get her back if she did not fulfill all his expectations. He gave me a look of fatherly pity, patted me on the back, and says: "I used to be just as afraid as you when I had only fired three years, and I thought I knew more than I do now; you might have to mark them, but I know what I am doing." But he did not. We limped over the division the next day, and he got me to say nothing, and told the round house foreman something was wrong with those eccentrics.

We made two trips all right, and he called me over near town and says: "Jack, you work too hard." My heart sank ten feet. "She burns too much coal; I'll fix that tomorrow." He changed her draft pipe and put in three inch nozzles, and she had a chill the next day, and we had to go into the front end on the road when it was red hot, and the water around the fire-box about hot enough to shave with. Then I commenced to monkey. I marked the draft pipe and sleeve, and after he got them set to suit his fancy on the next trip, I changed to suit mine when he was gone, and that night as her pop went up at 140 when he shut off, he smiled a self-satisfied smile, and says: "I got her there this time; one of these days I'll explain how that petticoat pipe acts on the fire." I am waiting yet.

He was only a sample of many men I know; they are forever "fixing" something that does not need it, or, if it does, they had better report it and have it done right. These tinkers do not like to pack, clean headlights or keep their cab fittings packed and in order. This is engineers' work: they like to pose as builders. Any engineer ought to know what work his engine needs, and ask to have it done. He is foolish to do shop work on the road; he ought to know better than to ask for new work when his engine is almost ready for the shop. He ought to be able to think of his running on the road and let the engine alone; if he has a superabundance of brains he can use them all to do his work right.

Practical Drawing.

BY J. G. A. MEYER.

THIRTY-SECOND PAPER.

320. The principles connected with finding the true form or outline of the upper surface $a\ c$ of the truncated prism shown in Fig. 226 can be better understood by studying the paths of a point, or several points, given in Fig. 231.

Let $A\ B\ C\ D$ (Fig. 231) be the vertical plane of projection, and $A\ B\ E\ F$ the horizontal plane of projection, standing perpendicular to each other. Also let $g\ h\ i\ j$ represent a given plane, standing perpendicular to the vertical plane projection $A\ B\ C\ D$, but not parallel to the horizontal plane of projection $A\ B\ E\ F$. In descriptive geometry it is proved that this given plane $g\ h\ i\ j$ will have two traces (Art. 229), namely: First, the vertical trace $g\ h$, which forms an angle with the ground line $A\ B$, equal to the angle formed by the given plane and the horizontal plane of projection; second, the horizontal trace $g\ i$, which is perpendicular to the ground line $A\ B$. In fact, a little reflection should make it apparent that when a plane, such as we have shown, stands perpendicular to the vertical plane of projection, and inclined towards the horizontal plane of projection, its horizontal trace must be perpendicular to the ground line $A\ B$; and its vertical trace must form, with the ground line $A\ B$, an angle equal to that between the given plane $g\ h\ i\ j$ and the horizontal plane $A\ B\ E\ F$.

321. In connection with this subject we may also add that when a given plane, $g\ h\ i\ j$ (Fig. 232), stands perpendicular to the horizontal plane of projection $A\ B\ E\ F$, and is inclined towards the vertical plane of projection $A\ B\ C\ D$, as shown, then the vertical trace $g\ h$ will be perpendicular to the ground line $A\ B$, and the horizontal trace $g\ i$ will form, with the ground line $A\ B$, an angle which is equal to the angle formed between the vertical plane of projection $A\ B\ C\ D$ and the given plane $g\ h\ i\ j$.

322. For the sake of clearness let us suppose that the given plane $g\ h\ i\ j$ in Fig. 231 is of a rectangular form, and given dimensions, that is, the sides of this rectangle (Art. 60) or the edges of this plane are parallel to each other and form right angles, and also that the width, that is, the distance from h to j or from g to i, is three inches, and the length, that is from g to h or from i to j, is six inches.

Now assume that the plane $g\ h\ i\ j$ is revolved (Art. 329) around its horizontal trace $g\ i$ until it coincides with the horizontal plane of projection $A\ B\ E\ F$, then, when coinciding with the horizontal plane, its position will be represented by the lines $g\ i\ h_2\ j_7$. In descriptive geometry we find the following principle: If from any point as j in the plane $g\ h\ i\ j$ a line $j\ i$ be drawn perpendicular to the line $g\ i$, and the plane $g\ h\ i\ j$ be revolved around the line $g\ i$, the point j will describe an arc of a circle—the radius of this circle is equal to the perpendicular $j\ i$ let fall from the point j on the trace $g\ i$, and the plane of the circle is perpendicular to the trace or axis (Art. 329) $g\ i$ because the trace $g\ i$ or axis is perpendicular to all the radii. Therefore the point i, in which the line $j\ i$ drawn perpendicular to the line $g\ i$, cuts the latter must be the center from which the arc $j\ j_7$ is drawn; and for similar reasons the point g must be the center from which the arc $h\ h_2$ is drawn. According to the foregoing principle we also conclude that the vertical plane of projection $A\ B\ C\ D$, which in this particular case is standing perpendicular to the horizontal plane $A\ B\ E\ F$, must contain or pass through the point g, the line $g\ h$, and the arc $h\ h_2$. In revolving the plane $g\ h\ i\ j$ around the line $g\ i$ the distance between the points h and j remains the same, namely three inches, therefore the arcs $h\ h_2$ and $j\ j_7$ are parallel. Again the arcs $h\ h_2$ and $j\ j_7$ are contained in a circular plane standing perpendicular to the vertical plane $A\ B\ C\ D$, and therefore we may say that the arc $h\ h_2$ and its center g are the vertical projection of the arc $j\ j_7$ and its center i. Therefore, on the vertical plane of projection $A\ B\ C\ D$ the path of the point j is represented by an arc described from the center g.

323. Once more, on the arc $j\ j_7$ let us mark off any number of joints as j_3, j_5, and then through the points j, j_3, and j_5, draw lines perpendicular to the horizontal plane $A\ B\ E\ F$; these perpendiculars will intersect the plane $A\ B\ E\ F$ in the points $j_2\ j_4\ j_6$; in fact, the latter points will be the horizontal projections of the points contained in the arc $j\ j_7$; the distance from any one of the points j_2, j_4, j_6 and j_7, to the ground line $A\ B$ will be three inches, and consequently a straight line can be drawn through all the points j_2, j_4, j_6 and j_7; this straight line $j_2\ j_7$ will be parallel to the ground line $A\ B$, and three inches away from $A\ B$. In fact, the line $j_2\ j_7$ is the horizontal projection of the arc $j\ j_7$, and since this arc represents the path of point j, it follows that in the horizontal plane the path of the point j is represented by a straight line $j_2\ j_7$.

324. The foregoing reasoning is true, and applicable not only to points in which the sides of a parallelogram intersect, but is also true for any given point in the revolving plane. Take, for instance, any point m in the plane $g\ h\ i\ j$, Fig. 231, and let this plane be revolved around its horizontal trace $g\ i$. Through the given point m draw a straight line $m\ n$ perpendicular to the line $g\ i$, and cutting the same in the point n; then will the point n be the center, and the line $m\ n$ the radius of the arc $m\ m_2$, which represents the path of the point m in the vertical projection. The straight line $n\ m_2$ drawn through the point n and parallel to the ground line $A\ B$, will represent the path of the same point m in the horizontal projection.

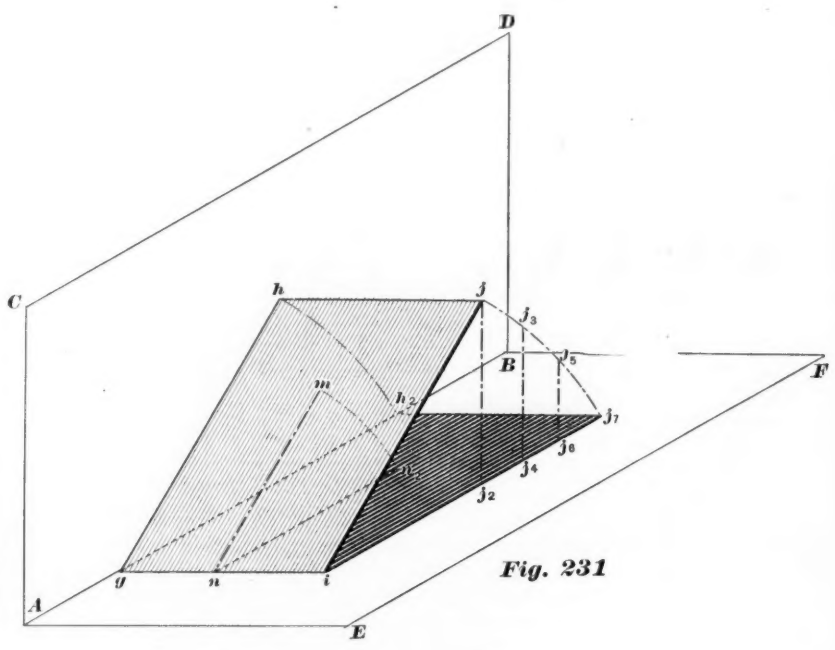


Fig. 231

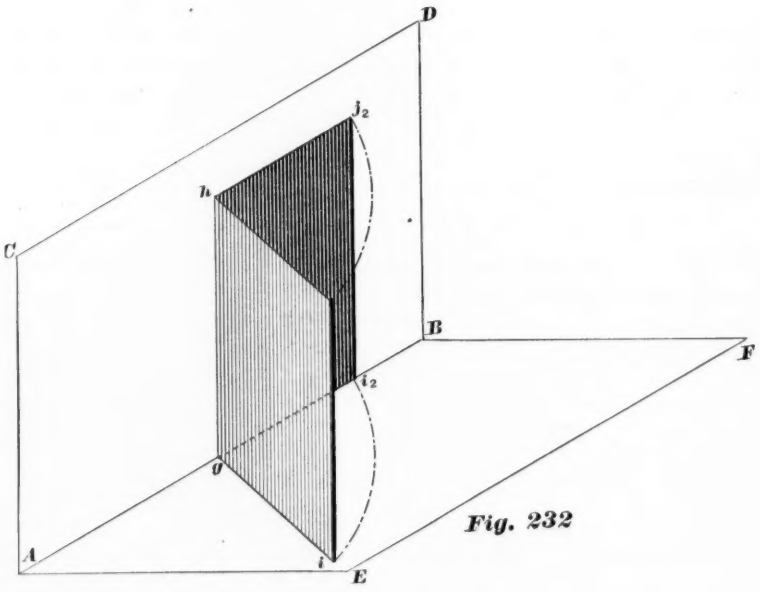


Fig. 232

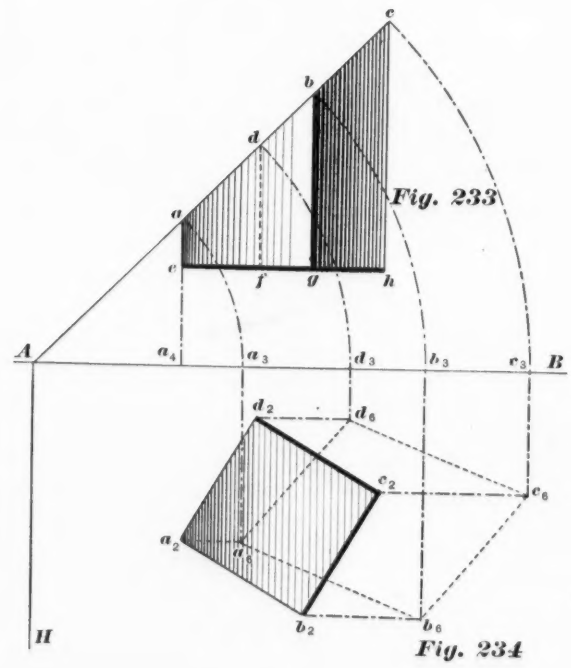


Fig. 233

Fig. 234

325. When a plane $g\ h\ i\ j$ stands perpendicular to the horizontal plane of projection $A\ B\ E\ F$, as shown in Fig. 232, and forming an angle with the vertical plane $A\ B\ C\ D$, then the path of any point, as j, in the plane $g\ h\ i\ j$, will be represented by an arc $i\ i_2$ in the horizontal plane $A\ B\ E\ D$, and the path of the same point will be represented by a straight line $h\ j_2$ in the vertical plane of projection $A\ B\ C\ D$.

326. Between the Figs. 233 and 234 we have shown the ground line $A\ B$, and turning to article 220 we see that the ground line simply represents the line in which the horizontal and vertical plane of projection intersect. This ground line $A\ B$ is placed between the vertical and horizontal projection of an object wherever it is convenient. Although in working drawings the ground line is never shown, the representation of the ground line in the problem before us, and smilar problems which are to follow, will greatly aid us in gaining a clear comprehension of the principles of descriptive geometry and principles connected with the solutions of the problems.

327. When a ground line is given, and also the projections of a point, we then know the relative position of the point in space, which has been projected, to that of the ground line; thus: Let a (Fig. 233) be the vertical, and a_2 (Fig. 234) the horizontal projection of a given point in space, we then know that the height above the ground line $A\ B$ of the given point in space is equal to the length of the line $a\ a_4$ (Fig. 233), that is the length of a line drawn from the vertical projection a to the ground line $A\ B$ and perpendicular to the latter; we also know that the distance measured in a horizontal direction from the given point in space to the vertical plane is equal to the length of a line drawn from the horizontal projection a_2 to the ground line $A\ B$, and perpendicular to the latter. The same remarks apply to any other points shown.

328. The projections of a line joining two points in space are found first by projecting the points, and then by joining the vertical projections of these points by a straight line, and also joining the horizontal projections of the points by a straight line. The lines thus obtained will be the vertical and horizontal projections of the line joining the two points in space. From this we conclude, and correctly too, that when we have the projections of two points of a line in space and join these by straight lines, we at once know the position of the line in space, that is, we know whether the given line in space is parallel or oblique to both or any one of the planes of projection, and also its distance from the planes of projections. In short, the two projections of a line determine its position in space.

329. A plane can be turned or revolved around a given line in that plane; the line around which the plane is turned is called the axis of revolution. In revolving any plane around its axis, for instance, like a door on its hinges, all the points and lines of the plane presserve their relative position.

330. Let us now apply these principles to the method of finding the true form or outline of the upper surface $a\ b\ c\ d$ of the truncated prism, of which a vertical projection is given in Fig. 233, and horizontal projection in Fig. 234, the same as shown in the last paper.

Anywhere between the two projections draw a horizontal line, $A\ B$; this line will represent the ground line. Prolong the line $a\ c$ towards the ground line $A\ B$, allowing the former to cut the latter in the point A; then will the line $A\ c$ represent the vertical trace and containing the point A of a plane coinciding with the upper surface $a\ c$ of the truncated prism, and this plane will stand perpendicular to the vertical plane of projection, and will form an angle with the horizontal plane of projection. But the point A is also a point in the horizontal trace of this plane; and therefore a line, $A\ H$, drawn through the point A, perpen-

dicular to the ground line $A\ B$, will be the horizontal trace. The length of the trace $A\ H$ is not limited, because we do not, and need not assign any length and breadth to the plane which is represented by the traces $A\ H$ and $A\ c$; we simply consider it to be sufficiently large to cover the upper surface $a\ c$ of the truncated prism, and containing the points which are represented by their projections a, b, c, d, and whose true relative positions we wish to find, after the plane has been revolved around the line $A\ H$, making it to coincide with the horizontal plane of projection.

The true relative positions of the points thus found may appear to differ from those of the points a_2, b_2, c_2, d_2, in Fig. 234; but it must be remembered (Art. 329) that the relative positions of points during the revolution of the plane do not change, and the cause of the difference in appearance is that in Fig. 234 the true relative positions of the points a_2, b_2, c_2 and d_2 are not seen Now assume that we are in the act of turning the plane around its trace $A\ H$, then in the vertical projection of the prism (Fig. 233), the paths of the points will be represented by arcs drawn through their vertical projectionst a, b, c, d, and in the horizontal projection of the prism (Fig. 234) the paths of the same points are represented by straight lines drawn parallel to $A\ B$ through their horizontal projections a_2, b_2, c_2, d_2. Therefore, from the point A as a center, describe arcs passing through the points a, b, c, d, cutting the ground line $A\ B$ in the points a_3, b_3, c_3, d_3. Also through the points a_2, b_2, c_2, d_2 draw lines parallel to the ground line $A\ B$. Through the point of intersection a_3 draw a line perpendicular to the ground line $A\ B$, and cutting the line $a_1\ a_6$ in the point a_6. Again, through the point d_3 draw a line perpendicular to the ground line $A\ B$, and cutting the line $d_2\ d_6$ in the point d_6. The points a_6 and d_6 will be the horizontal projection of the points represented by a and d after the plane $A\ c$ has been revolved to coincide with the horizontal plane of projection. Join the points a_6 and d_6 by a straight line, then the line $a_6\ d_6$ will be the horizontal projection—after the plane $A\ c$ has been revolved to coincide with the horizontal plane of projection—of the edge represented by the line $a\ d$ in the vertical, and $a_2\ d_2$ in the horizontal plane of projection (Art. 328). In a similar manner we find the positions of the other lines $d_6\ c_6$, $c_6\ b_6$, $a_6\ b_6$; thus:

Through the points b_3 and c_3 draw lines perpendicular to the ground line $A\ B$, allowing the line through b_3 to cut the line $b_2\ b_6$ in the point b_6, and the line through c_3 to cut the line $c_2\ c_6$ in the point c_6. The positions of the points a_6, b_6, c_6, d_6, thus obtained, are the true relative position of points in which the sides of the upper surface of the truncated prism intersect, and these points we have considered to be given points in space, whose true relative positions had to be determined.

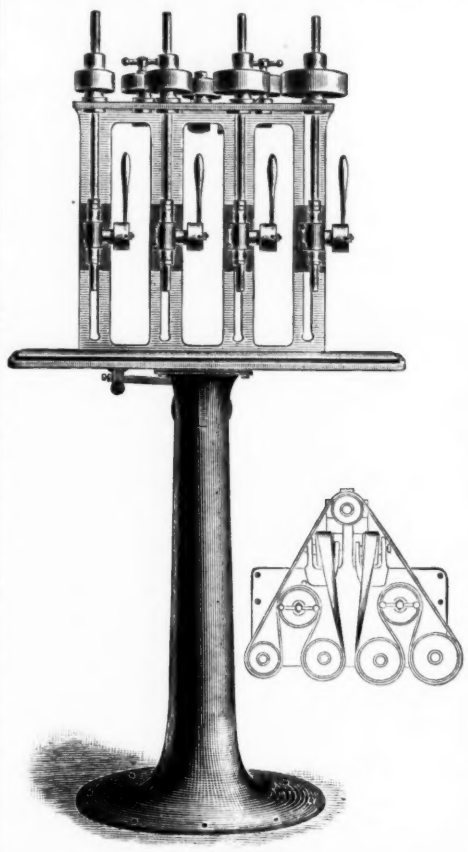
Join the points d_6 and c_6, c_6 and d_6, also a_6 and b_6, and thus obtaining the parallelogram $a_6\ b_6\ c_6\ d_6$, which represents the true outline of the upper surface of the truncated prism.

For the sake of distinction we have shown this parallelogram in dotted lines. Now comparing the same with the parallelogram $a_6\ b_6\ c_6\ d_6$, in Fig. 229, we find that both are alike in every particular, and that the method adopted for finding one is precisely the same as that adopted for finding the other; the only difference that can be seen, or which really exists, is that Fig. 229 has been moved to a convenient distance away from Fig. 227, so as to avoid a confusion of lines, which to some extent exists in Fig. 234.

German competition in glass making has led inventors in Belgium to study more mechanical means of doing the work. The plan contemplated is to roll out glass substantially in the same way that iron or steel plates are rolled. The sheets are to be rolled, cut into sizes, and conveyed to the annealing oven, all by machinery. "Shapes" may be rolled, it is believed, the same as in iron or steel.

Four-Spindle Sensitive Drill.

The drill herewith illustrated is new and of somewhat novel design. The spindles are all driven with a single endless belt, which, without lacing, gives smooth and easy motion, without vibration. It is also a saving in expense over the plan of keeping four or more short belts in condition. The endless belt also gives largely increased belt contact. It will be seen that this endless belt is kept at proper tension by means of two tightening pulleys on movable studs. This enables change to be made in the ratio of velocity of spindles without changing the length of belt.



SENSITIVE DRILL.

The spindle-driving pulleys run on studs attached to the frame, thereby taking all lateral strain from the spindles, which are driven by bushing and key in top of the hub of spindle drivers, the key fitting into spline in spindle. Either of the four spindles can be adjusted as to height by simply loosening a hand nut on the back of post.

The weights of spindles, feed levers, and chucks, are counterbalanced, so that there is no resistance to downward motion except the material being drilled.

The drill shown will drill holes from 0 up to ½ inch, and is complete and compact. It is mounted on a column, and has heavy table with drip groove for oil or soda. The spindles are made of tool steel ¾ inch diameter, 23½ inches long. They are adjustable on the post to distance of 12¾ inches from top of table to bottom of spindle, and when set have a throw of 3¼ inches by feed-lever. Distance from center to center of spindles, 6 inches; from face of column to center of spindle, 5 inches. The spindle-driving pulleys are 3¼, 4, 4¾, and 5½ inches in diameter. On the back stud the tight and loose pulleys are 4¾ inch diameter, 1⅞ inch face; for general work they should make 875 revolutions per minute, giving the spindles 1,279, 1,039, 875, and 755 turns respectively. In speeding, the work to be done is to be considered.

An endless belt to run the spindles is furnished with each drill, also key drift for chuck shanks, together with chain and ring.

The manufacturers are Dwight Slate Machine Company, Hartford, Conn.

Contract Labor in County Penitentiaries.

The Syracuse *Evening Herald* says:

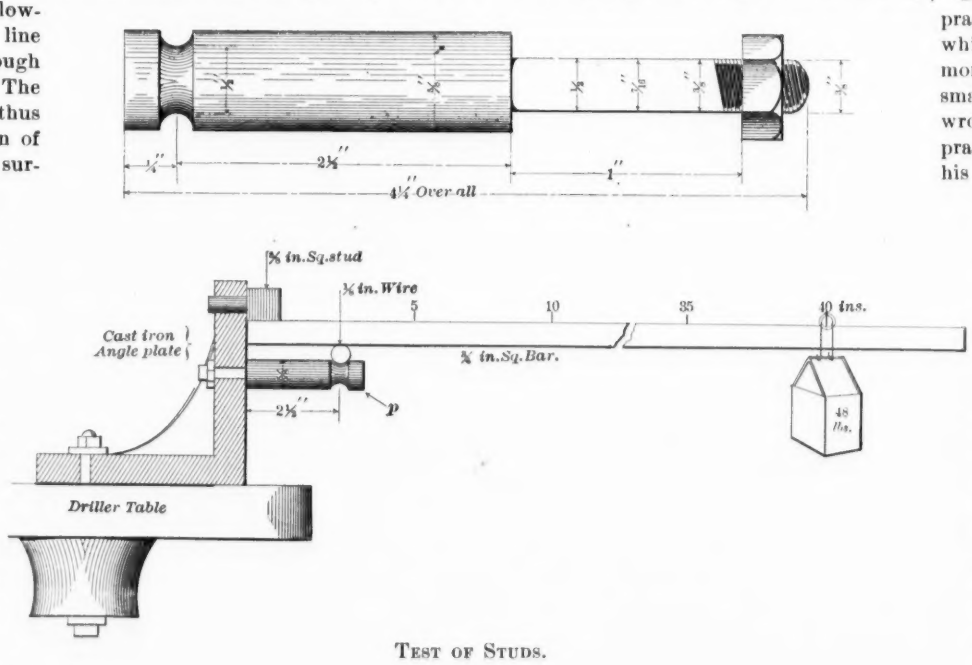
The contract system in New York State prisons dies hard, but happily there isn't much left of it. On the thirty-first of this month the contract of the Bay State Shoe and Leather Company will expire, and then that prison will be free from the presence of the money-making contractors. The only remaining contract is at Auburn prison, and that has not long to run. The work of establishing industries on the State account is progressing well. The stove plant of Perry & Company at Sing Sing has been bought by the State, and that industry will keep busy a large number of hands; and it is expected that the machinery of the Bay State Shoe and Leather Company will also be acquired. The people of this State have declared against contract convict labor, and this decision is being respected in the management of the State prisons, but what can be said of the Onondaga Penitentiary, where, under the thin guise of a lease and an agreement, the contract system to all intents and purposes is being continued? The spirit of the law is plainly violated, and the prisoners are subjected to all the rigors of the contract system, and free labor is made to undergo the competition of manufacturers who are making their goods at the lowest prison prices.

A Lathe with a War History.

Tim Murphy has in operation in his shop in this city a lathe which is worthy of more than a passing notice. This lathe is capable of taking a piece of iron, eighteen feet long and four feet four inches thick, and is the one Mr. Murphy worked at when an apprentice in Miller's shop, in Savannah, during the war.

When it was known that the Federal troops would inevitably make an invasion of the Forest City, all the tools and machinery of Miller's foundry and machine shop were removed and sunk in the Savannah River, in order to keep the Yankees from using them, and among these was this lathe. The action of the Confederates in this respect was, however, thwarted, as the Yankees learned where they were sunk, and immediately raised them again, and put them into use. After the war, the lathe was sold at Master's sale, and was purchased by Mr Murphy and brought to this city, where he has had it constantly in use ever since.

Many of the ordnance guns used in the Confederate service were turned out from this lathe; and for this reason, and the fact that he worked at it when a boy, Mr. Murphy has a tender feeling for it, and would not part with it for any consideration.—Jacksonville, Fla., *News Herald*.



TEST OF STUDS.

A World's Fair in 1892.

The *Sunday Times*, published at Stapleton, Staten Island, and certain citizens of that enterprising isle are very active in urging the claims of Staten Island as the proper place in which to hold the projected World's Fair in 1892, in celebration of the discovery of America by Christopher Columbus four hundred years earlier. We fear these enthusiastic gentlemen have forgotten the famous culinary recipe, in which the first of the directions given was: "Catch your hare." Is it certain there is to be a World's Fair in 1892? If it is, Staten Island may be a first rate place in which to exploit it. As has been well said, the event celebrated was maritime in its nature, and the proposed Exhibition could not overlook a nobler sheet of water than New York bay. There has been rather a surfeit of World's Fairs of late years, but the benefit that American industrial interests derived from the Centennial Exposition of 1876 are still discernible, and as much progress in many directions has been made meantime, and the event is well worth celebrating, we shall be glad to hear that the project is in hands competent to carry it through.

LETTERS FROM PRACTICAL MEN.

"Easy Way" on Studs.

Editor American Machinist:

In reply to Mr. Shaw's article of July 23d I wish to notice four points which he makes. The controversy between Mr. Shaw and myself is upon the following subjects:

Mr. Shaw first asserted that the common practice of making the part of the stud which enters the supporting piece (commonly called the "neck" of the stud) smaller than the body of the stud was wrong. I claimed that this common shop practice was exactly right. Mr. Shaw, in his article of the 23d, claims that he has proved by figures and signs and symbols that I am indisputably wrong.

To prove myself right I have had made and tested three ⅞" studs, and I now claim that my test of these studs shows I am exactly right, and Mr. Shaw all wrong in this matter.

Mr. Shaw's article of July 23d was illustrated by a drawing. This drawing represents a stud 6 inches long by 1½ inches diameter, with a neck 1⅛ inches diameter. An allowable load for this stud is, according to Mr. Shaw's figures and statements, 216 pounds. To figure this out Mr. Shaw selects the compression resistance of the annular bearing of the stud on the cast-iron piece which supports the stud, as representing the entire possibilities of the case, and proceeds to calculate the strain which this surface will safely support, and gives his result, 216 pounds, as the safe load for a stud of the sizes above-named.

Undoubtedly Mr. Shaw had no intention of anything like selecting an unstable element of stud stability, and so making calculations based on this variable element to make his side of the argument good. But it is beyond question that in making the selection he did, Mr. Shaw acted without due circumspection; for the strain on the

metal which supports the base of a transversely loaded stud is a compression strain with certain proportions of neck to body of stud, and an extension strain with certain other proportions. And further, the common shop practice is such as to leave that field of stud support which Mr. Shaw assumes as bearing the whole strain of the load in a nearly neutral condition, as the compression and extension strains nearly balance each other. This statement was fully borne out by the simple tests hereafter detailed.

The correct statement in regard to strains on the metal supporting the base of a transversely loaded stud is as follows: The larger the neck of the stud the smaller the compression strain on the face of the metal; when the neck equals the size of the body the effect of destructive strain is to elongate a portion of the supporting metal. Conversely, the smaller the neck the greater the compression strain on the face of the supporting metal.

Very clearly then, in assuming a field and a strain which varies from something to nothing, Mr. Shaw has taken a basis of operation which gives him ground for very widely differing conclusions; and if Mr. Shaw will take the trouble to examine this matter fully he will find himself arriving at contradictory results, I think. He will certainly find that after he passes a certain point of neck diameter the less surface he has to resist the stud shoulder strain the greater will be the load on the stud required to crush that resisting surface. Hence I assert without fear of contradiction that Mr. Shaw's figures prove nothing general, however true they may be as deductions from his assumed premises; and indeed, the trifling load of 216 pounds for a $1\frac{1}{2}$ inch stud only six inches long should at once have shown that there was something wrong with the premises of the problem.

Again, Mr. Shaw asserts that he can show the condition of greatest stud efficiency in resisting strain to be where the nut is screwed up slack, just enough to make an actual contact between the shoulder of the stud and the abutting surface. This is certainly wrong; the nut should be and always is in practice, screwed up hard; and under moderate loads, well within the strength of a given stud, the deflection will always be found much less with tightly screwed stud nuts, than with a slack job. This statement is so obviously true, and so constantly recognized by shop practice, that I cannot understand how Mr. Shaw came to make it, and I am curious indeed to know by what arguments he can sustain his position.

That I might have an actual test of the matters in controversy I had three steel studs made, as shown in the shop sketch, page 5. As will be seen, all of these studs had $\frac{3}{8}''$ nuts, and $\frac{5}{8}''$ bodies, and one had a neck $\frac{1}{2}''$ diameter, one $\frac{7}{16}''$ diameter, and one was made $\frac{3}{8}''$ neck. The nuts were all made $\frac{3}{8}''$ because I have often put larger nuts on studs than I wished, because I was not certain the smaller ones would be strong enough. To test these studs I made use of a small angle plate bolted to a driller table, as shown in the following sketch:

I considered the $\frac{3}{8}''$ and $\frac{7}{16}''$ shanks much too small, while the $\frac{1}{2}''$ shank was my usual practice, with a $\frac{1}{2}''$ nut, for a $\frac{5}{8}''$ stud.

I therefore first put the $\frac{3}{8}''$ shank stud into a $\frac{3}{8}''$ reamed hole in the angle plate and screwed the nut up hard, and set a surface gauge to the out-board top surface of the stud. I next bent the stud down with the $\frac{3}{4}''$ square bar, by pressing on the bar with my hands, until the outer end of the stud was $\frac{1}{16}''$ below its normal position. Upon removing the bar, the stud was found, when the surface gauge was applied, to stand as at first. This would seem to show that a neck so small as $\frac{3}{5}$ the diameter of the body of the stud was large enough for ordinary conditions, as I think the stud was loaded to at least 400 pounds, though as to this I cannot say positively, as the pressure was made with the hand.

I next bent the stud down with the lever until it received a permanent set at the free end of $\frac{1}{16}''$ and then removed it from the angle plate. The nut and thread were uninjured. The seat of the shoulder on the angle plate was distinctly marked in the lower half, and indented to about the thickness of thin paper. The body of the stud was not bent. The bend in the neck was almost wholly at the junction of the neck and body.

The angle plate was then lined up to make a fair seat for the $\frac{7}{16}$ stud neck, and the $\frac{3}{8}$ hole reamed up to $\frac{7}{16}$, and the $\frac{7}{16}$ neck stud put in and screwed up hard.

I then bent this stud by hand pressure, until the point had a permanent drop of

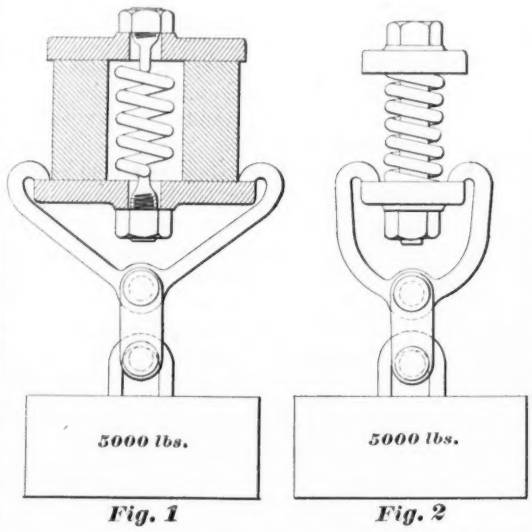
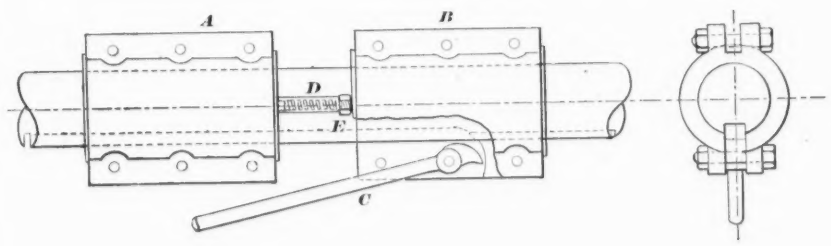


Fig. 1 *Fig. 2*

EFFECT OF INITIAL STRAIN ON BOLTS.

$\frac{1}{16}''$, and removed it from the angle plate. The power required was very sensibly more than that used to bend the $\frac{3}{8}''$ neck, while the angle plate was not so deeply marked as with the smaller neck. The screw and nut were uninjured. The neck of the stud had its greatest bend about $\frac{8}{16}''$ back of the shoulder of the stud. In this connection I should, perhaps, mention that the angle plate used to support the studs was about 1" thick. The body of the stud was bent enough to be only barely perceptibly out of truth, with a good straight edge. It will be seen that all the indications were in favor of the $\frac{7}{16}''$ neck. The angle plate was less marked, the bend in the shank was more generally distributed, and the body of the stud had suffered somewhat under the destructive strain.

Lastly the $\frac{7}{16}''$ hole was reamed up to $\frac{1}{2}''$, and the angle plate was faced down to give the stud shoulder a fair bearing; and the $\frac{5}{8}''$ stud, with neck $\frac{1}{2}''$ in diameter, was put in the angle plate, and the $\frac{3}{8}''$ nut screwed up hard.



ENLARGING A KEY SEAT.

A 48 lb. weight was then placed successively, at 5 inch intervals, along the $\frac{3}{4}''$ square bar, and the stud tested at the free end with a surface gauge after each test, and found to stand at the same point through all the trials, up to and including that at the 40 inch mark, thus showing that a $\frac{5}{8}''$ stud, $2\frac{1}{2}''$ long, with a $\frac{1}{2}''$ neck, was not strained beyond its elastic limit by a weight of over 768 lbs. at its free end.

At this point of the trial the stud was removed from the angle plate and tested on dead centers and found perfectly true. The screw and nut were uninjured, and the cast-iron seat of the shoulder on the angle plate was so slightly marked as to merely show a difference in the color of the iron without an appreciable depression.

From these experiments, simple and rude as they were, I draw the following conclusions, which I am certain will not be successfully disputed, viz.:

A good shop practice for studs is to make the proportions as follows:

Diameter of body = 1.
" " neck = $\frac{4}{5}$.
" " screw = $\frac{3}{5}$.

It is very certain that in practice a $\frac{5}{8}''$ stud is seldom loaded up to 400 pounds, and as a $\frac{5}{8}''$ stud of the above proportions stood nearly 800 pounds' strain without permanent deflection, I think its proportions must be pronounced practically good.

Now let me compare my results with those given by Mr. Shaw. I will not take his "area of cast-iron abutting contact." If I did there would be a still greater discrepancy between figures and practice. I will take the lengths and diameters of the studs.

Mr. Shaw used $1\frac{1}{2}''$ diameter $\times$ 6" long; length equal to 4 diameters, and a neck $1\frac{1}{8}''$ diameter = $\frac{9}{12}$ of body diameter = $\frac{45}{80}$.

I used $\frac{5}{8}''$ diameter $\times$ $2\frac{1}{2}''$ long; length equal to 4 diameters, same proportion as Mr. Shaw used; and a neck $\frac{4}{5}$ body diameter = $\frac{45}{80}$. Thus our studs were nearly identical in proportion, and, since circles are to each other as the square of their diameters, a $\frac{5}{8}''$ stud should have, other things being equal, $\frac{25}{144}$ of the strength of a $1\frac{1}{2}''$ stud.

Mr. Shaw says a $1\frac{1}{2}''$ stud is safe under 216 pounds' load, hence my $\frac{5}{8}$ stud should be "safe" under $\frac{25}{144}$ of 216 pounds, which is something less than 40 pounds.

Now my $\frac{5}{8}$ stud, as I have stated, really did bear without permanent injury nearly 20 times as much as Mr. Shaw says it is safe to put on it. True, Mr. Shaw's stud was a stud of paper and figures, while my stud was, and is, a machine shop stud of steel. But is not 20 rather a large "modulus of elasticity" for a scientific and elaborate mathematical conclusion?

Without any jest I really think Mr. Shaw was wrong somewhere. I'm sure I don't know where, as I have not looked over his figures.

And as Mr. Shaw seems aggrieved by the impersonality of "Easy Way," I will sign myself for this once only,

HORACE L. ARNOLD.

Effect of Initial Strain on Bolts.

Editor American Machinist:

I cannot fully agree with Mr. Kent's discussion of the effect of the initial strain on bolts due to screwing up. I understand him to reach the general conclusion that such strain is not to be considered as forming part of the total load, in such cases, for instance, as steam cylinder cover bolts.

This depends entirely upon the elasticity of the bolt and the pieces held together. Mr. Kent's first figure represents the case of an elastic bolt and non-elastic pieces, and for that case his solution is correct. His second figure may represent either the case with elastic bolt or elastic pieces, and while the solution is correct for the former case, it is incorrect for the latter.

Imagine a block between two washers, all pressed firmly together by a bolt passing through them, and consider the two extreme cases.

CASE I.—ELASTIC BOLT AND NON-ELASTIC BLOCK.—Let the bolt be represented by a powerful spring, as in Fig. 1. Let the block be fixed and let the nut be screwed up to produce an initial strain of 5,000 pounds, and then let the stirrup with its weight of 5,000 pounds be added. Under these conditions, the added weight will not increase the strain, because if it should the spring bolt would stretch under it, the block being non-elastic would not follow, the lower washer would leave contact with the block, and the supposed increased strain would instantly relieve itself—hence there can be no such increase.

CASE II.—ELASTIC BLOCK AND NON-ELASTIC BOLT.—Let the block be now represented by a spring, as in Fig. 2. As before, let the nut be screwed up to produce an initial strain of 5,000 pounds, and then let the stirrup and weight be added. Obviously the bolt is now loaded with a strain of 10,000 pounds, because, unlike the first case, the second load has in no way affected the first.

In actual cases the situation is more involved, as both block and bolt are elastic, and the question becomes one of difference of elasticity; but the conditions and the final effect vary between the two cases shown as extremes. It is sometimes possible, but more often impossible, to say which extreme is most nearly approximated, but when the whole matter brings on such obscure conditions, the only safe course is the conservative one, to regard the initial load as part of the final strain.

Since writing the above, I have discovered substantially the same analysis in Unwin's Elements of Machine Design, to which your readers are referred.

FRED'C A. HALSEY.

Tarrytown, N. Y.

Enlarging a Key Seat.

Editor American Machinist:

While in charge of a 15 stamp mill, with 1,000 pound stamps that I had just built and started far from any machine shop, I had occasion to enlarge the key-way on the cam shaft. The shaft was $5\frac{1}{2}''$ diameter, of hammered iron; the key-way $1\frac{1}{8}''$ wide by $\frac{3}{8}''$ deep; the cams would come loose, no matter how much I drove the keys, and once loose they would chatter so severely as to widen their key seats, so that while a new key might be made to fit top and bottom, it would still be loose sideways. There was no help for it but to shut down and widen and deepen the key. I adopted the device shown in the sketch, which proved to be just the thing theoretically and practically; there was really no hitch from first to last. The shaft was in two pieces in one line running in four boxes. I took the cover or caps off the boxes and bolted them on, as shown, the covers *A* being bolted tight on the shaft, while the working covers *B* were lined so as to be loose on the shaft when the bolts were screwed fast. Sufficient of the cover *B* was cut away to admit of the tool *C*—$1\frac{9}{16}''$ wide—to work freely; the feed device *D* was a piece of ordinary 1" pipe with a $\frac{7}{8}''$ screwed piece of wrought-iron inserted, having a nut *E*. When all was ready, two men got on the lever part of the tool, which, by means of piping, extended out about four or five feet, while one man attended the feed arrangement *D*. The travel of the tool was something like 80 to 90 degrees, the feed for each stroke of the tool was $\frac{1}{8}$ of a turn of the nut *E*. It took something like a week to go over the full length of the cut, which was 12 feet in all.

The tool was made from a piece of $1\frac{1}{4}''\times1\frac{1}{4}''$ American tool steel. I stood by while the native blacksmith was drawing the temper, and when "dove's neck" was reached, I excitedly caught hold of his arm and shoved the tool deep in the can of oil provided for the purpose. That slight circumstance saved the day, for it was the only piece of that kind of steel within two or three weeks' journey. In case anything might go wrong with it, I had an auxiliary tool made from German steel (the only kind in town). When ready it was tried, but it chipped all over; it was dressed again and

again with always the same result, so that the first tool did the whole of the work without dressing.

When finished the keys had a section of $1\frac{9}{16}'' \times 1\frac{1}{8}''$; when driven with a 16-pound sledge hammer they "stayed" without further trouble.

The key-way when finished was smoother than if done by a planer, but not just so uniform throughout its whole length; stretches of it 6" and 7" long were as perfect as if milled out. The shape of the tool admitted of sharpening without materially reducing its reach. The job was done without removing the shaft from its bearings.

It will be seen from the above that the dimensions of keys ought to be proportional to the work to be done by them; further that it might be set down as a mechanical axiom that keys that have the work brought on them with a violent "slap," as in stamp mill cams, would stand to be double the area usually allowed.

JOHN A. CALDWELL.

Hubs and Prints.

BY ROBERT E. MASTERS.

Fig. 1 represents a practice followed in some shops in fitting up the center of pulley and plain gear arms for the hubs. A recess is turned in the plate of the arms, and a pair of hubs turned to suit. One pair of hubs are made to answer for several size shafts. Conversing on this point in a shop where it was practiced, the foreman of the foundry congratulated himself, "if he didn't have much iron in the hub around a $3\frac{1}{2}''$ shaft (where there was considerable to pull), he had an abundance around a $1\frac{1}{4}''$ shaft (where there was little or no strain)."

In a go-as-you-please foundry the plates in all the half pulley patterns had screw holes in them, and the hub screwed on as near the center as the moulder could get it, after running all over the place to borrow a screw-driver. The hubs on loose wooden arm patterns were all nailed fast when in use, and pulled off and replaced by other sizes when occasion called for it. The core prints on all kinds of wooden patterns were nailed fast (Fig. 2), and when the size of the core is to be changed, some one must carry the pattern up in the third story of a building to the pattern maker, or have him come down to the foundry; and if there is one thing above another that will cause a pattern maker to be supremely happy, it is to have to gather up a lot of tools and go down into the foundry to make a little change in the pattern, and then have to make half a dozen trips back and forth before the work is completed.

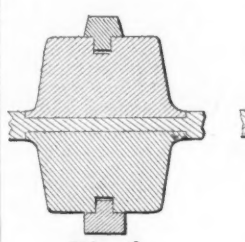


Fig. 1

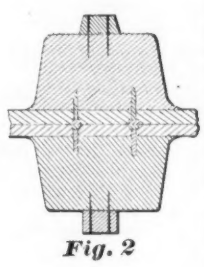


Fig. 2

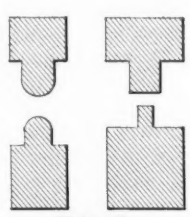


Fig. 3

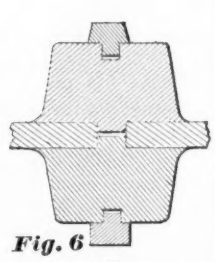


Fig. 6

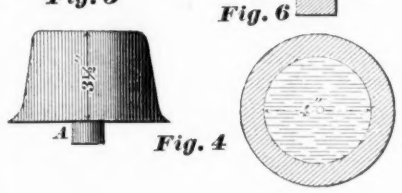


Fig. 4

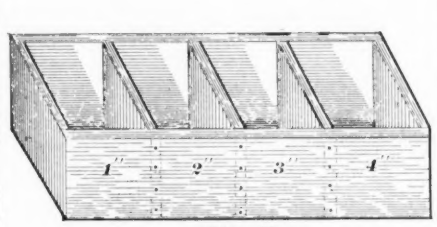


Fig. 5

HUBS AND PRINTS.

Prints that are nailed on pattern cause loss of time and inconvenience in the foundry. If it is a flat surface pattern that is to be rammed up in a drag and turned over, and only one to be made, holes must be cut in a board to let the prints through, or the cope rammed up first, and the pattern bedded on it.

I wonder what system of architectural engineering ever induced any one to have a pattern shop on the top floor of a three-story building, especially for foundries that do heavy work. If there is some change to be made in a pattern for a large punch or shears, planer or engine bed, what a delightful time they have with the profitable labor of several men getting the patterns upstairs and down again.

A Handy-Andy pattern maker connected with a firm doing a good business, furnished all core prints as shown by the cluster, Fig. 3. When making the patterns, he picked up the first bit at hand, no matter whether it was $\frac{1}{4}''$ or $1\frac{1}{4}''$, and bored a hole for the stem of the print; then made the stem of the print to suit it. The result was a big supply of long and short prints, without being able to find one to fit the hole in the pattern or hub, if it is necessary to change the size of the core. The dowel on the print is either too large or too small for the hole in the pattern. After trying prints for half an hour, if you have not by chance found one to fit, you can wait another half hour for one to be made.

In a works where everything is kept in systematic shape, I was shown into a small room adjoining the foundry, and on shelves I saw hubs of all sizes, arranged in pairs according to size. On the sides and top of each hub the depth and diameter had been painted in plain black figures before they were varnished. (See elevation and plan, Fig. 4.) The stem *A* was 1" diameter and fitted a corresponding hole in all patterns requiring hubs. On other shelves top and bottom prints above 4" diameter, increasing in size by $\frac{1}{4}''$, were also arranged in pairs. A box, Fig. 5, in a convenient place in the foundry contained in compartments designated by the figures on the outside prints of all sizes increasing by one-eighth inch up to 4". To make it more thoroughly understood, the compartment marked 3" contained three pairs of prints of each size from 3" increasing by eighths to $3\frac{7}{8}''$. Prints of all diameters were $1\frac{1}{4}''$ long; the top prints are cone shape and the bottom prints straight or nearly so. The prints, like the hubs, have their diameters painted on in plain black figures. They all have $\frac{1}{4}''$ wrought-iron stems or dowels in them; this prevents the moulder from trimming down the stem to make it fit loose and have the hole most anywhere in the casting.

All hubs and patterns of every description that require straight round holes in them have a hole bored to suit the dowel, and the size of core needed marked beside the hole for the print. The firm referred to make a great many pulleys and gears, and when the foundry foreman gets an order for a half-dozen pulleys of the same or different diameters, but each one for different size shafts, he picks out hubs and prints to suit and any of them fit as in Fig. 6 without going to the pattern maker; when through, prints, hubs and patterns are returned to their places; the foreman strictly enforces this. All pulley patterns are of iron and have their diameter marked on them with white paint.

In the store room for gear patterns each pattern had a brass plate let into the face and stamped in plain figures, thus:

Gear No. 40, Wt. 3,500,
74" dia., 12" face,
3" pitch, 79 teeth,
Pinion No. 52.

Pinion No. 52 refers to the pinion that usually works with the gear. Where a gear is made for an outside party their name is entered on the pattern book with the number of the gear, so that there is no trouble to find it. The plates on the gear segment also state the number of pieces it takes to form the circle. To put these figures on hubs, prints and patterns does not take but very little time as each pattern is made, but in the end saves a great deal of time and prevents mistakes in the foundry.

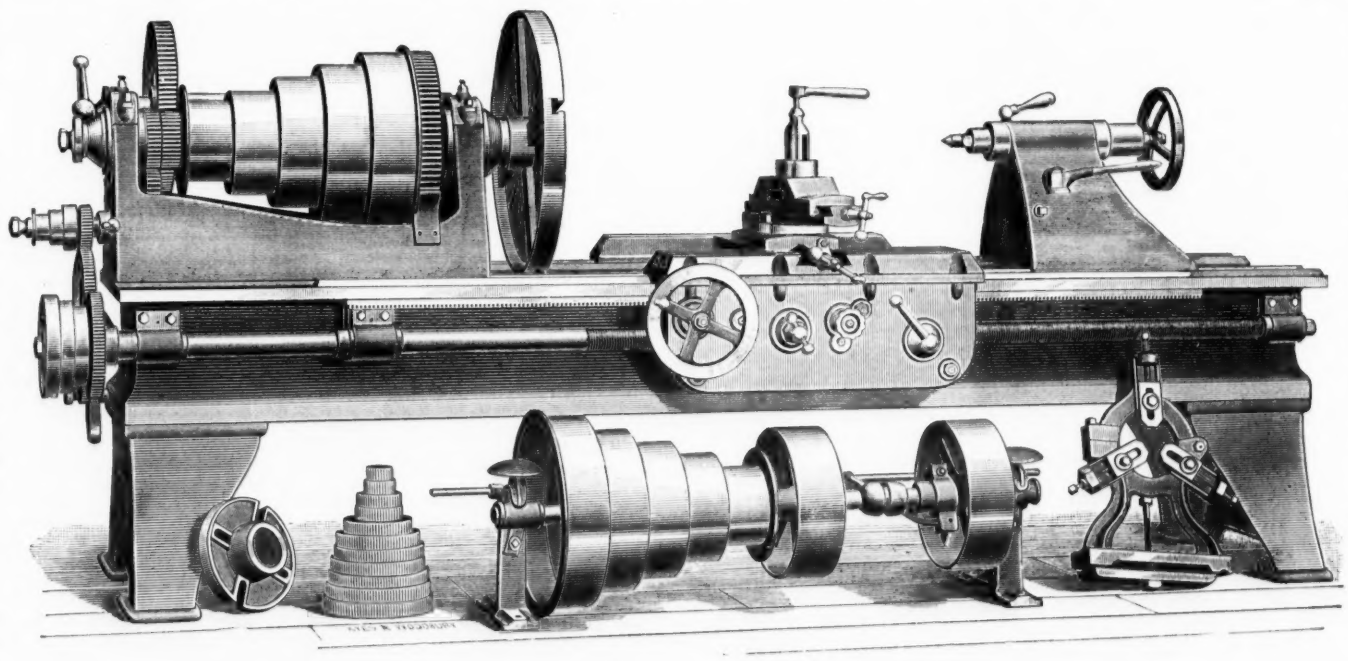
In the core room all straight cores were made in diameter to suit the prints, and in three lengths, one end tapered, so there would be only a little to cut off the straight end if a 6", 10" or 15" core was wanted. The cores were made in iron boxes; one-half of the box of each diameter and length had lugs cast on it. There was quite a number of the other halves of each size with grooves cast in them to fit the lugs. When the core was rammed up the half of the box with the lugs on was lifted off and the other half put in the oven with the core in it. Nearly all of the core boxes were made in this way without any work required on them in the machine shop, care being taken to get them moulded smooth.

The cores were kept in stock on partitioned shelves, each compartment marked with the diameter and length of cores contained. A knowledge of the work done taught the man in charge of the core room the amount to keep on hand.

New Engine Lathe.

The engine lathe illustrated with this is one of the latest brought out by Fay & Scott, Dexter, Maine. It swings 28 inches, with length of bed to suit. Spindles are of steel, the head spindle being 4 inches diameter, with front bearing 7 inches diameter. The feed, both transverse and longitudinal, is by means of splined screw and belt, and independent screw-cutting feed. The compound rest is indexed. The largest diameter of cone is 18 inches for 4-inch belt. Friction pulleys on countershaft are 14 inches diameter. The carriage has double apron, giving bearings on each end of the carriage shafts. The parts are conveniently arranged for quick manipulation, and the lathe is strongly built for heavy work.

The manufacturers' agents are Fraser & Archer, 121 Chambers street, New York.



NEW ENGINE LATHE.

It takes the foundation of a big hotel, a car load of stakes to mark lots with, a street railroad franchise, a flume and irrigation company, and an auction sale of lots to make a town in Southern California. A piece of land is also needed.—*San Francisco Chronicle.*

At the steel works of Hoerde, near Dortmund, Germany, apparatus has been put up to produce 35,000 cubic feet of water gas and 140,000 cubic feet of Siemens gas per hour.

A new use for natural gas has been developed at Kokomo, Ind., according to the *Tribune* of that town:

Matthew Murden understands the uses of natural gas, and knows how to put it where it will do the most good. He has a flambeau erected in his chicken yard that answers a two-fold purpose. It keeps thieves from purloining his fowls, for one thing, but the greatest good he gets out of it is that his hens lay day and night now, as they don't know when to go to roost. Matthew thinks he is entitled to the same honor, as a benefactor, as the man who caused two blades of grass to grow where only one grew before.

The re-discovery in late years of the quieting effect of oil upon an angry sea is leading to the invention of something better than a bag filled with oakum for distributing it The latest device is a hollow globe of metal, so made as to float in an upright position. An opening in the bottom admits water which displaces the oil through a graduated opening at the top.

Instead of plugging up the hole for a wood screw, from which the thread has drawn out, with wood, it is said if plugged with cork that it makes a much better job,

AMERICAN MACHINIST

To prevent delays all Communications should be addressed to the Company.

PUBLISHED WEEKLY
BY
American Machinist Publishing Co.
HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.
96 Fulton Street, New York.
F. F. HEMENWAY, Mechanical Engineer.

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once.*

Subscription.

$2.50 a year in advance, postage prepaid in the United States, Canada and Mexico.
$3.50 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
11 BOUVERIE STREET, Fleet Street, LONDON, ENG., will receive subscriptions for the AMERICAN MACHINIST, at 14/7 per annum, postage paid.

DEALERS SUPPLIED BY
The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Toronto News Co., Clifton, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y.

NEW YORK, SEPTEMBER 10, 1887.

CONTENTS.

	PAGE
Richards' Oil Engine	1
Drilling Holes. By Fred. J. Miller	1, 2
Protecting Inventions in Switzerland	2
Player's Graduated Expansion Cam	2
Need of Special Tools for Making Standard Machinery. By W. H. Hoffman. Third Paper.	2, 3
Improved Independent Chuck	3
Tinkering Engineers. By John A. Hill	3
Practical Drawing. By J. G. A. Meyer. Thirty-second Paper	4, 5
Four-Spindle Sensitive Drill	5
Contract Labor in County Penitentiaries	5
A Lathe With a War History	5
A World's Fair in 1892	5
Letters from Practical Men—"Easy Way" on Studs. By Horace L. Arnold—Effect of Initial Strain on Bolts. By Fred'c A. Halsey—Enlarging a Key Seat. By John A. Caldwell	6, 7
Hubs and Prints. By Robert E. Masters	7
New Engine Lathe	7
The Solid Emery Wheel	8
Expert Evidence in Patent Law Suits	8
Elevator Inspection	8
Politics and Fire Protection	8
Questions and Answers	8, 9
Manufactures	9
Machinists' Supplies and Iron	10

The Solid Emery Wheel.

It is reasonably certain that no single thing that has been added to the outfit of the machine shop, since the metal planer came into use, has had a more important effect in increasing both quantity and quality of work than the solid emery wheel. This is saying a good deal for an insignificant disk of mineral, but reflection is likely to lead to the belief that it is true. The use of planers multiplied the employment of plane surfaces, because it made their production feasible. It increased the area of wearing surfaces, gave stability to attached parts, and brought about a hundred other good things. The use of the emery wheel has rendered practicable about as many things that before its advent were only possible—hardly that—and hence were not done, or done at great expense.

Aside from the use of the solid emery wheel to rapidly remove metal, its advent has brought about the devising of a line of extremely ingenious machinery for shaping and grinding metal too hard to be operated upon by the ordinary tools of the trade. This is not only a matter of great economic value in many machine processes, but it has wonderfully improved the quality and cheapened the cost of many small tools of the trade, and done a good deal to further interchangeability of parts of machines. In every tool room of a well-appointed machine shop the small grinding machine is a necessity; in the shops large grinding machines and emery wheels mounted in a variety of ways are scarcely less so. These machines, as before said, are admirable in their way, but they are the direct outgrowth of the homely cutting disk. Given something to do the cutting satisfactorily, and the machine was sure to follow, although in the early days of solid emery wheels the most sanguine hardly expected they would become part of tools of precision for such a variety of work.

The solid emery wheel, and the machines in which it is used, mark an era in the machining of metals about as completely as that which was inaugurated by the introduction of metal planers. In the present knowledge of the art of milling metals the planer could be spared for many purposes for which it is used, but it would be difficult to find a substitute for the emery wheel, yet there are some thousands of machine shops in which a study of its utility has never been seriously attempted. In the well appointed shops in the country it is responsible for some of the best work that goes out.

Expert Evidence in Patent Law Suits.

Since our editorial bearing the above title, and published last week, was put in type, we have received a circular from Prof. R. H. Thurston, of Sibley College, Cornell University, in which he notifies his clients that, owing to other claims upon his time, he will hereafter undertake to give testimony before a commissioner in important legal cases only, or to supervise the work of junior experts, but that he cannot, as a rule, undertake to appear in court. In addition, he uses the following significant language:

"I should in all cases prefer to respond to the interrogatories of the court, with approval of both sides, rather than serve either litigant alone."

We have no information as to the motive that prompted the remark quoted above, but can well appreciate the desire of a high-minded man, whose knowledge and methods of research are of value to the industrial community, to avoid being placed at one and the same time in the anomalous position of an impartial witness and a highly paid "technical attorney," retained in the interest of a single litigant.

Speaking with reference to this same subject of "Expert Evidence in Patent Law Suits," a Western manufacturer, who is himself a somewhat prolific and very successful inventor, writes us:

"I have been well pleased with the way you have been treating the patent question of late, and think it cannot fail to do good. As to 'experts,' I advocate abandonment of them altogether, and the appointment of 'Commissioners in Patent Causes,' before whom the testimony shall be taken, the same as now before 'masters in chancery,' said commissioners to be thoroughly 'up' in patent matters and able to see through a hole without the aid of experts to tell them white is black. The commissioners should be assistants to the U. S. judges, who cannot spare the necessary time to listen to all the testimony. The latter should be printed, and afterward arguments should be made before the judge and commissioners, who would then be in position to decide. In most cases this would give satisfaction. The commissioner would look into the 'equity' of the case and the judge into both law and equity. I think some such way would be fair, and get rid of paid experts, who are no doubt a nuisance to both judge and clients."

Our Western friend's suggestion, it will be seen, does not differ essentially from that advanced in our article last week, except as to his proposition looking to the entire abandonment of the practice of employing paid experts. We do not think a litigant could or should be prevented from employing the best possible skill in the preparation of his case. Our correspondent's suggestion that the proposed 'commissioners in patent causes' should be officers of the court, and men 'thoroughly up in patent matters,' is substantially identical with our argument favoring the appointment by the court of trained experts, to investigate the case, who should, for the time being, represent the court, and not the private interest of either litigant.

Elevator Inspection.

The recent elevator "accident" in this city, attended, as it was, by loss of life, calls attention again to the subject of elevator inspection. We acknowledge having in the past put forth some effort to bring about elevator inspection; we have honestly argued that the elevator was becoming more deadly than the steam boiler, and that it ought to be looked after. But we protest that the kind of inspection this elevator got was not the kind we meant.

It appears that the elevator in question was inspected about one week before the accident. The prime cause of the trouble was due to the failure of a pinion, which, it may be granted, inspection could not have foreseen. But the real cause appears to have been that the safety catches were inoperative.

If it is assumed that something in the way of machinery or the rope is never to fail, then safety catches on an elevator are as useless as the proverbial fifth wheel to a vehicle. But the fact that these safety catches are provided is good evidence that the presumption is that some of the mechanism may fail. The intention is to provide for safety, in spite of such failure—that such failure shall amount to nothing more serious than a little delay.

In neglecting to inspect that part of the machinery of the elevator which is really intended to make it safe, the inspector appears to have stopped a long way short of his duty. It was a case of looking after the spigot and leaving the bung-hole wide open. The manufacturers say that the safety part of the elevator was, from neglect, in no condition to perform its important function. Inspection that stops short of looking after the main safety feature of an elevator is not the inspection we advocated. It is foolish to anathematize that luckless pinion, as the daily press has done. There are several things about the machinery of an elevator that, being in almost constant use, are liable to fail. In fact, it is only a question of time when some one of these parts may be depended upon to fail. And this is why the safety device is placed between their failure and the fall of the cage.

This accident will bring out another crop of new devices to arrest the too precipitate descent of the elevator cage. Some of these may be good; but the probability is that, under the same circumstances, they would be as useless as the safety device of this elevator was. If the loss of life attending the falling of this elevator cage shall teach the elevator inspectors what to inspect, it may not be entirely useless. If common sense does not teach them that the safety catches, being the last hope of the unfortunate passenger, should receive the brunt of inspection, then it is probable that nothing but loss of life will teach them. If the inspectors learn this—that ought to be self evident—it will be of more service to the public than a hundred new safety devices. We still believe that elevators are more dangerous than steam boilers, and that their so-called inspection can be materially improved.

Last week we made the suggestion that human life in this country was by law rated altogether too low in dollars and cents, and expressed our belief, that if it cost a railroad corporation $50,000 or $100,000 to kill a man, instead of $5,000, there would be few or none killed from preventable causes. We believe it might be well to extend the principles involved in this kind of a price list to steam boilers also. At present, buyers and makers of shoddy boilers take altogether too small a share of the risk involved in their use. Our legislators cannot do a better thing than to bring them to a realizing sense of the fact that killing people at least costs money.

The coroner's jury in the railroad disaster in Illinois exp nded most of its energy in censuring a section boss, who was arrested in accordance with its recommendation. We do not think this verdict will in any way change public opinion. The section boss may or may not be blamable in the matter; the courts will determine that. But if he was as much in blame as the jury declare him to be—which in justice to him it should be said is doubted by many—he was only a very small part of an extremely blamable system of railroad operating.

Politics and Fire Protection.

In recent issues we have called attention to the defenseless condition in which many towns and villages are all over the country with respect to protection from either retail or wholesale conflagration. Intimations have reached us that more than one large city has more politics than protection in its fire department management and facilities. Baltimore and Pittsburgh have been freely named in connection with this charge. Fires are notoriously un-partisan in their nature and performances, and if anybody has ever offered any good reason for regarding political faith, or the personal interests of any politician, in selecting either fire department chiefs or the rank and file, regulating their tenure of service, or appropriating or spending the money needed to make the force effective, ordinarily or in emergencies, we are in ignorance of its existence.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(364) W. W. K., Newark, N. J., asks: **What is the liquid preparation used for writing on glass, the writing appearing as if engraved?** *A.*—**It is said that a solution of fluoride of ammonium may be used with a quill pen. Or you can cover the glass with wax, trace through and eat with fluoric acid.**

(365) N. S., Chattanooga, Tenn., asks: **Suppose I want to fit a hub on a 1 15-16 inch shaft. For ordinary work the hole must be a little over 1 15-16 inch, or the shaft a little less. Is there a recognized standard for such work? If so, should I make the shaft scant or the bore in the hub full?** *A.*—**The more common machine shop practice is to make the holes in hubs standard size. Cold rolled shafting, and we think hot polished shafting, is made standard size.**

(366) R. W. A., Buffalo, N. Y., asks: What is the smallest or sharpest practical curve of railroad rails? *A.*—The radius of curve of railroad rails greatly depends upon the class of locomotives to be used. The radii of curves on railroads cannot be as small as the radii of curves in manufacturing establishments which use very small locomotives. In the latter you will find curves whose radii are 75 feet.

(367) W. D., Philadelphia, Pa., asks: 1. How are the screws for micrometer calipers made and finished to have them as true as they are? *A.*—They are made and finished in a lathe with the same care as is practiced for obtaining any other kind of accurate work. 2. Can a screw of any pitch be called a micrometer screw? *A.*—Any screw that is used in a micrometer—that is, an instrument for measuring very small distances—may be called a micrometer screw.

(368) N. S., ——, writes: 1. Will a plug pointed at the end, and driven into a hole, have less pressure on it and be less liable to blow out than one just left square on the end and driven in? *A.*—The pressure on both will be the same, and one will be as liable to blow out as the other. 2. What is the advantage of a pointed plug over a square-ended one? *A.*—None, except that the pointed plug can be entered into the hole more readily than the square-ended one.

(369) B. E. W., Jackson, Miss., asks: 1. In applying lacquer to brass, should the brass be heated, and if so, in an oven or over an open fire? *A.*—It should be moderately heated in an oven. 2. How can a drill be tempered so as to drill chilled iron or steel? *A.*—Make your drill of the very best steel, and leave it as hard as you find by experience it will stand. Some recommend driving it in a block of lead to harden; others cooling in brine; still others in mercury. Our experience has been that water was as good as any thing.

(370) S. D. T., Providence, R. I., writes: I have a paper tube ¼ of an inch in diameter, and want to paint it inside with a waterproof paint of some kind. Can you tell me of any such paint or mixture? *A.*—Let ¼ pound of india rubber, in small pieces, soften in ½ pound of oil of turpentine; then add 2 pounds of boiled oil, and let the whole boil for 2 hours over a slow coal fire. When dissolved, add again 6 pounds boiled linseed oil and 1 pound litharge, and boil until an even liquid is obtained. It is applied warm, and forms a waterproof coating.

(371) J. B., Milwaukee, Wis., writes: Will you please explain more clearly (to a common man) the rule to make the taper of tube ends, which I find in your issue of March 19th, 1887, page 7. What is the meaning of 1 in 32 to axis of tube? *A.*—By axis is meant an imaginary line running lengthwise through the center of tube; by 1 in 32 is meant that the amount of taper is equal to 1-32 part of its length. Thus: If the length of the taper is 1 inch, then the amount of taper in that inch is 1-32 of an inch; that is, at one end of the inch the material is 1-32 of an inch less than at the other end; if the length of taper is 12 inches, then the amount of taper in that length (12 inches) will be ⅜ of an inch; in short, when the taper is to be 1 in 32, then the amount of taper for any length is found in dividing the length by 32; the quotient will be the amount of taper. Consequently, the expression of "1 in 32 to the axis of tube" means that the taper measured from the axis of the tube is 1-32 part of the length of the taper, or, in other words, one-half of the diameter at one end of the taper is less than one-half the diameter at the other end of the taper, and the difference is equal to 1-32 part of the length of taper. Thus: If the length of the taper on a 2½ pipe is 1 inch, and the taper is to 1 in 32 to the axis, then one-half of the small diameter will be 1-32 of an inch less than one-half of the large diameter, or, which amounts to the same thing, the whole small diameter will be 1-16 of an inch less than the whole large diameter. 2 Do different sizes of pipes have different tapers? *A.*—No; the taper for all pipes is 1 in 32 to the axis of tube. 3. What angle should a compound rest be set at to turn the proper taper? *A.*—1 4-5 degrees. See AMERICAN MACHINIST, page 6, November 28th, 1885.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Brass Gears. See Adv., page 16.

Link-Belting.

Send for catalogue of Link-Belting.

Over 50,000,000 feet of Link Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Air Compressors, Rock Drills. J. Clayton, 43 Dey st., NY

Exhaust Tumbl'g Bbls. Henderson B's., Waterb'y, Ct.

Upright Drills from 20" to 36" inclusive. Currier & Snyder, Worcester, Mass.

For Improved Cooper Stoves, send to Variety Machine Co., Warsaw N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., Y. N.

Robbs' Patent Composition for case-hardening. Send for circular. F. W. Tasney, Paterson, N. J.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Injectors, Ejectors, Oil Cups, Sight Feed Lubricators, etc. Arthur Appleton, 45 Cortlandt st., N.Y.

Ice and Refrigerating Machines. 124 built, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y

Drawing Materials, all kinds. Get catalogue. Mention this paper. G. S. Woolman, 116 Fulton st., N. Y.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg. Co., 111 Liberty st., N. Y.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 92 Park row, N. Y.

Machinists' supplies, brass goods, m'f'rs' supplies, polishing materials, all kinds wire, metals, etc.; in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

Press for sale. Quick-acting; hole in bed, 8x5, punches to center of 13-inch sheet; 2¼-inch shaft; also four-spindle Drill. B. W. Payne & Sons, Elmira, New York.

Reed's Engineer's Hand-Book to the Local Board Examinations. Eleventh edition revised and enlarged, with 260 diagrams and 36 large plates. 8vo., cloth, $4.50, post-paid. Catalogue of books free. E. & F. N. Spon, 35 Murray st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2 post-paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York

MANUFACTURES

Toronto, Ont., needs new pumping engines.

Clarksburg, W. Va., will vote on the water-works question.

A carriage factory is to be built at Anniston, Ala., by John B. Fry.

The citizens of Phœnix, N. Y., have voted to put in water-works.

Jeffersonville, Ind., is to locate a water-works plant immediately.

C. B. Wright is building a steam saw mill and ginnery at Dixon Falls, Ala.

The National Iron and Brass Works, Dubuque, Iowa, will enlarge their plant.

Wm. Sears & Co., of Manistee, Mich., will establish a cracker factory in that city.

There is excitement at Nacogdoches, Tex., over the discovery of paying oil wells.

Carley Bros., machinists, have recently begun business at Colfax, Washington Ter.

The Western Electric Light Company will build a factory on Superior street, Chicago.

Sprague & Day, Wesley, Me., have their mill and blacksmith shop nearly completed.

Local papers predict a fortune in store for any one who will start a paper mill in Texas.

Water-works will be built at Kinsley, Kan. The stand-pipe system will probably be used.

A special election will be held at Lapeer, Mich., to vote upon the question of water-works.

The citizens of Pana, Ill., are about to have water-works if they can get them by voting.

The machine works of George R. Lombard & Co., Augusta, Fla., recently burned, will be rebuilt.

A cotton mill is to be built at Big Falls, N. C. J. V. Pomeroy, of Charlotte, N. C., is interested.

The Case Engine Company, New Britain, Conn., have recently begun business. Capital stock, $300,000.

The Electric Machine Company, of West Lynn, Mass., have purchased ground and will proceed to build.

The Columbia Rolling Mills, Columbia, Pa., will improve their plant by the addition of new puddling furnaces.

The burned shop of the New York Belting and Packing Company at Sandy Hook, Conn., will be rebuilt at once.

Foster & Brown, Saccarappa, Me., are reconstructing an old church into a convenient machine shop and foundry.

The Lamb Knitting Machinery Company, Chicopee Falls, Mass., are making extensive additions to their shop room.

The New Albany Electric Light and Power Company, New Albany, Ind., expect to put in a $40,000 electric lighting plant.

The Rio Grande Sugar Company, of Cape May county, N. J., are about to remove their sugar manufacturing plant to Florida.

The Athens Mining and Manufacturing Company, Athens, Tenn., will take stock in manufacturing companies that will locate there.

The Waterbury Clock Company, of Waterbury, Conn., is building a 405-foot addition to their present plant on Mill and Pond streets.

A company, with a capital of $4,000,000, has been formed at Rockford, Ill., to work the iron ore beds recently discovered at Waukon, Iowa.

The Clark & Hodges Furniture Company is a new concern starting to manufacture furniture at Grand Rapids, Mich. Capital stock, $5,000.

The burned carriage shop at Westport, Conn., will not be rebuilt. Mr. L. T. Burns, the lessee, is looking about to establish himself elsewhere.

At Wichita, Kan., a company has been formed with a capital stock of $150,000, to establish a wire and wire nail factory.—*National Labor Tribune.*

The shops and yards of the L. and N. Railroad, to be built at Decatur, Ala., will cost $350,000. The erection of the buildings will be begun at once.

The Reliance Gauge Company, Cleveland, Ohio, has issued a very convenient pocket catalogue descriptive of their alarm gauges and safety water columns.

The Hastings Steam Pump Company, Brooklyn, N. Y., has been incorporated; capital stock, $50,000. Henry W. Thurston and others are incorporators.

Pawnee City, Neb., is to vote upon the question of issuing bonds for the erection of water-works. The plans of the engineer contemplate a pumping engine and stand-pipe.

The Land Improvement Company, of Kalamazoo, Mich., have closed a contract for the erection of a large soluble capsule manufactory that will give employment to 200 hands.

The Bailey Manufacturing Company, of Hartford, has leased for five years the factory building nearly opposite the depot in Wethersfield, Conn. It will be used chiefly in making copying presses.

The Ironstone Manufacturing Company is the name of a new company at Sprin field, Ill. The company propose to erect works, and manufacture material for paving out of the slag from iron furnaces.

A company, to be known as the Sheffield Agricultural and Machine Works, has been organized at Sheffield, Ala. They will build agricultural machinery, and do a general foundry and machine business.

The Diamond Drill Company, Birdsboro, Penn., will enlarge their works by the addition of a new shop, 85x165 feet. This will be stocked with new machinery, and an additional force of workmen employed.

The New York Central Iron Works, Geneva, N. Y., have issued a new illustrated catalogue of steam-heating appliances, steam engines and boilers, etc. They also do all kinds of mill work and sheet-iron work.

The Wickwire Brothers, Cortland, N. Y., have begun building a new wood shop at their wire works near the Elmira, Cortland and Northern station. The building is to be 80 feet in length, 45 feet wide, and four stories high.

J. A. Lidback, Portland, Me., will ship five 15 horse-power "Lidback" engines and one of 40 horse-power this week, all to parties within the State. He is making preparations to engage in their manufacture on a larger scale.

The Henry Martin Brick Machine Company has been chartered at Lancaster, Pa., for the purpose of manufacturing brick machines. Capital stock, $50,000. They contemplate erecting a foundry and machine shop in the near future.

The Howe Stove Company, recently organized at Cortland, N. Y., bought the stove works at Fulton for $81,000. The manufacturing of stoves will be continued at Fulton for the present, but in the near future the works will be removed to Cortland

The old brick shoe factory building, now occupied by Luther S. Johnson, at the corner of Mt. Vernon and Exchange streets, Lynn, Mass., is to be torn down in a short time, and a new and larger structure erected, to be arranged for stores and factory purposes.

The Adams & Richards Machine Company, New Brunswick, N. J., have fitted up a new shop, equipped with new tools, for building their oil engine. They report excellent prospects for business in this engine, which they have perfected and fully guarantee.

A correspondent writes us: "Mound City, Kan. is on the boom. New brick buildings going up; new court-house; complete system of water-works, and plenty of natural gas and coal. The Mound City Improvement Company offers special inducements to parties looking for location."

A public test and exhibition of the Woodward electrical storage battery was made in Detroit, Mich., recently, and proved to be, so it is claimed, a complete success. A number of Detroit capitalists are interested, and immediate steps will be taken for the manufacture of the new batteries.

The Springfield (Mass) Shoe Company will begin business next month at 51 Taylor street, on the premises now occupied by F. H. Goldthwait & Co., button manufacturers. The concern intend to turn out 600 pairs of shoes daily, and will employ 75 hands, the men and women being equally divided.

The Springfield *Republican* says: "The Chapman Manufacturing Company, of Meriden, Conn., will make a set of brass-plated saddle chimes for the Prince of Wales, who ordered them through a New York firm. This is another pleasant testimonial of the superiority of American industries."

The Fairbanks Scale Works, St. Johnsbury, Vt., are putting up a building which will increase the floor capacity 20,000 square feet, and a large amount of new machinery will be added. The company was about 6,000 orders ahead the first of this month, and are shipping about three car-loads of goods a day.

Northwestward the natural gas boom wends its way. A company has been formed at Duluth, Minn., to bore for natural gas, with a capital of $8,000. The work will be in charge of a man from the Pennsylvania regions. The town of Albert Lea, in the southern part of the State, is enthusiastic over natural gas finds.

The *Industrial Journal*, of Bangor, Me., says: "A fine chance for manufacturing is offered at Caribou, where a water-power of twenty feet head can readily be obtained. The banks on each side of the stream are so high that the cost of damming would be light, especially as a ledge runs across at the most eligible point. A fourteen-foot dam would give sufficient power for all manufacturing purposes."

The Star Whiting Company has organized at Grand Rapids, Mich., to engage in the manufacture and sale of whiting, terra alba, carpenter's chalk, billiard chalk, school crayons and other like materials. The stockholders are all Grand Rapids parties, and are as follows: James R. Shelby, James Quinn, jr., Jas. H. Wykes, H. P. Baker, Samuel A. Morman, Alva B. Richmond, J. F. Ferris, G. R. Mayhew and W. H. Boyns.

The "Cherokee Marble and Mining Property" has been organized and received its charter. The company owns about 1,400 acres of land near Murphy, Cherokee county, N. C., said to contain valuable iron ore, and will proceed to develop it. It is to have railroad connection at an early date. Among the directors are Prof. Ruffner, of Virginia, president; Gen. T. M. Logan, of New York; A. B. Andrews and Judge Schenck, of North Carolina; Col. J. G. Gibbs, of Jacksonville, Fla.; Gens. Haskell, McCrady, Wilbur and Memminger, of Charleston, S. C.

The Bridgeport (Conn.) Boiler Works are unusually busy on Lowe boilers and feed-water heaters. There has just been shipped from the works to the Illinois Condensing Company, Elgin, Ill., one 50 and one 80 horse-power boiler, with all improvements. The 50 horse-power is to carry 150 lbs. steam. With these two the company will have nine boilers, and with those in the factories of the New York Condensed Milk Company a total of 36, aggregating 2,500 horse-power. More Lowe boilers and feed-water heaters have been shipped from the works this year than in the same time any previous year.

At a meeting in Wolfboro, N. H., to consider the matter of rebuilding the shoe factory, burned Wednesday, it was voted to rebuild, and steps were taken to forward the work. The building will probably be ready for operation in January. A dispatch was received from Cropley & Monroe, of Marblehead, within fifteen hours from the time of the fire, to the amount of $100,000, assuring citizens of the town that they would continue the business if they would rebuild the factory. Twelve buildings were entirely consumed, and nothing in the stock or machinery from the factory was saved. Among the losses not before mentioned are goods, clothing, tools, etc., belonging to the operatives, which were destroyed, valued at $2,000, making a total loss of $142,000, on which there is not more than $25,000 insurance.

The Bridgeport Paper Company, Bridgeport, Conn., is about to make extended additions and improvements to its plant in North Bridgeport. A building will be added to the rear of the mill, 150 feet long by 50 feet wide, two stories high. A paper machine will be put in, capable of turning off seven to nine tons a day. Two new steam engines are to be added—one of 150 horse-power and the other of 50 horse-power. A 100 horse-power boiler will be provided in addition to the present 300 horse-power plant. Three beaders and a washer, all new, will be set in position. White paper only is manufactured. The new machine is guaranteed to run 250 feet of paper a minute. Ground wood pulp and cotton waste are used. The wood pulp is procured in Nova Scotia. Nelson Curtis is the practical man of the works.

According to the *Daily News-Herald*, Tim Murphy, of Jacksonville, Fla., is enlarging his machine works, having recently bought a shipyard lot on Bay street, near Catharine street, for $9,000, where he has already begun operations for the erection of a new and substantial machine shop, blacksmith shop and foundry. The machine shop will have a frontage on Bay street of 45 feet, extending back 70 feet, with an "L" 20x35 feet in size. The machine shop proper, together with the "L," will be two stories high. The second story will be used for the making of patterns and the storing of the same. Beyond the machine shop will be situated the foundry, which will be 25x70 feet in size, in addition to which there will be erected a large and commodious blacksmith shop. Mr. Murphy expects to have the buildings completed and ready for occupancy by Christmas.

A press dispatch says: "Dennis Ryan, the St. Paul millionaire, and a company of Eastern capitalists, began the erection of the largest smelting and reduction works in the country in Tacoma, W. T., yesterday. The capital stock of the company is placed at $2,000,000, and the works are to turn 400 tons of ore daily."

Machinists' Supplies and Iron.

NEW YORK, Aug. 25, 1887.

Iron—There is nothing new in the market for American pig. Foundry irons are only offered in about sufficient quantities to supply the demand, but in mill irons there is some accumulation. Standard brands of No. 1 X Foundry are quoted at $21 to $22; No. 2 X, $19 to $20.50; Grey Forge, $17 to $18.

Scotch Pig—There has been a fair demand for Scotch brands. We quote Coltness, $22.50 to $23; Gartsherrie, $21.50 to $22; Summerlee, $21.50 to $22; Eglinton, $20.50 to $21; Dalmellington, $20.50 to $21.

Lead—Prices are nominal, there being no business of consequence. Common Western is held at 4.60c., but there are no takers at this price.

Antimony—Hallett's, 8¾c; Cookson's, 9c. to 9¼c.

Copper—The market is fairly quiet, with some effort required to maintain prices; sales of spot have been made at 10.60c. Casting brands have sold at 9¾c. to 10c.

Spelter—Refined, 5¾c. to 6c.

Tin—Jobbing lots of Banca have sold at 24c.; Straits and Malacca, 23.30c.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Situation wanted by a well-posted designer and machine draftsman. Address T., AM. MACHINIST.

An experienced man to lay out all kinds of boiler work wants situation. Address Boiler Maker, AM. MACHINIST.

Experienced foreman for machine shop. Volker & Felthousen Mfg. Co., manufacturers of duplex steam pumps, Buffalo, N. Y.

Wanted—By a young man, a position as traveling salesman for steam goods, or iron and steel trade. Address D., AM. MACHINIST.

Mechanical draftsman—7 years' experience locomotives, machine tools, hoisting machines—desires situation. Address W., care AM. MACHINIST.

A first-class mechanical engineer and draftsman, with long experience, is open for engagement; best references. Address Box 53, AM. MACHINIST.

A young man, with 5 years' experience in shop and drawing room, desires position as assistant draftsman. Address E. L. C., 314 Fourth street, So. Brooklyn, N. Y.

Wanted—Experienced foreman on fine machine tool work in shop of 80 men; state previous experience, age, nationality, and salary expected. Address Philadelphia, care AM. MACHINIST.

Situation wanted by a first-class machinist and tool maker; seven years as foreman; fully understands construction and use of special tools and machinery. Lock Box 1130, Ansonia, Conn.

Wanted—Position by young man 10 years as machinist and draftsman; some experience in designing and making tools and special machinery. Address Steady Habits, care AM. MACHINIST.

An expert in designing and constructing pumping and general machinery is open for position as supt. and chief draftsman; been 27 years with one of the largest firms. Expert, AM. MACHINIST.

A first-class mechanical engineer and draftsman, with theoretical knowledge and extensive practical experience in designing, estimating and constructing, is open for an engagement. Address D. E. C., P. O. Box 568, Chicago, Ill.

Mechanical engineer and practical machinist solicits correspondence from parties wanting mechanical supt or foreman; large experience in all classes of marine and stationary engines, mining, mill and general machinery. M. E. M., AM. MACH.

Wanted—By a business man who is a mechanical engineer, a position; understands the necessity of doing business for the purpose of making money; is practical in getting up cost, not for curiosity, but for money-saving reasons; can design some classes of machinery; would want a good salary, which he could earn in a position proper for him. Address Nemo, AM. MACHINIST.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

The Cyclone Steam Flue Cleaner is king, and has no rival. Crescent Mfg. Co., Cleveland, Ohio.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Light mach'y of all kinds built at short notice Edmund Mills, 8 Dey st., Jersey City Heights, N. J.

Stationary boat engines, boilers, best, cheapest, 1 to 10 H. P. Washburn Engine Co., Medina, Ohio.

Special tools and machines for mfg. designed and built to order; mechanical and Patent Office drawings. I. A. Weston & Co., Syracuse, N. Y.

A. C. Christensen, 26 Church st., N. Y., mech'l engineer, late chief draftsman at Worthington's. Mechanical and patent drawings of all kinds to order. Patentee of natural gas meters.

Wanted—A second-hand shaping machine, modern make, in good condition, medium small size. Address, with full description and price, Eastman Freight Car Heater Co., 50 State st., Boston, Mass.

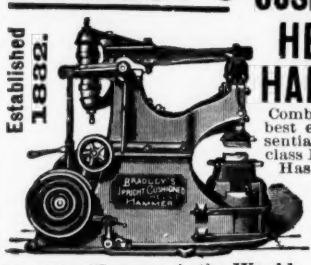
For Sale—Foundry and machine shop doing a good business. Parties wishing to engage in this business will get a bargain by calling on or addressing the Albion Foundry and Machine Works, Albion, Ind.

If you are troubled with scale in your boiler, whether from lime, sulphur, iron, salt or other mineral or corrosive water, send for circular of Petroleum Resolvent, adopted on one hundred railroads. Contains neither alkali or acid, and costs but ten cents a week for the largest locomotive boiler. Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

BRADLEY'S HEATING FORGES.

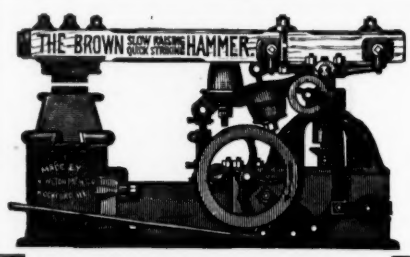
For Hard Coal or Coke. Indispensable in all shops to keep **Bradley's Cushioned Hammers** and men fully employed and reduces cost of production.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER



Combines all the best elements essential in a first-class Hammer. Has more good points, does more and better work and costs less for repairs than any other **Hammer** in the **World.**

BRADLEY & CO. Syracuse, N.Y.



THE BROWN HAMMER
STRIKES A BLOW WITH
Double the Velocity That it Raises the Hammer.
A NEW MOVEMENT! SEND FOR DESCRIPTION.
KNOWLTON MFG. CO., KING ST., ROCKFORD, ILL.

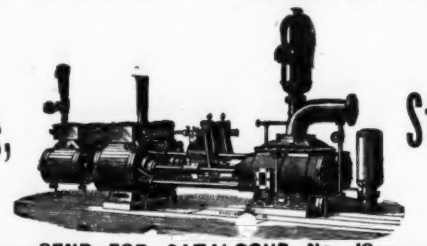
ONE-HALF TIME and LABOR saved by using this solid, strong, durable, firm-hold, quick-working Lever (Not Screw) Vise. Has improved Taper-Pipe and other attachments. Sold by the trade. Send for circular.
TOWER & LYON,
95 Chambers Street, New York.
Successors to MELVIN STEPHENS.

SEBASTIAN, MAY & CO.'S
Improved Screw Cutting
FOOT or POWER LATHES.

Catalogue of Lathes, Drill Presses and Machinists Tools and Supplies mailed on application. *Lathes on Trial.*
167 W. Second St., CINCINNATI, O.

THE DEANE STEAM PUMP CO., Holyoke, Mass.

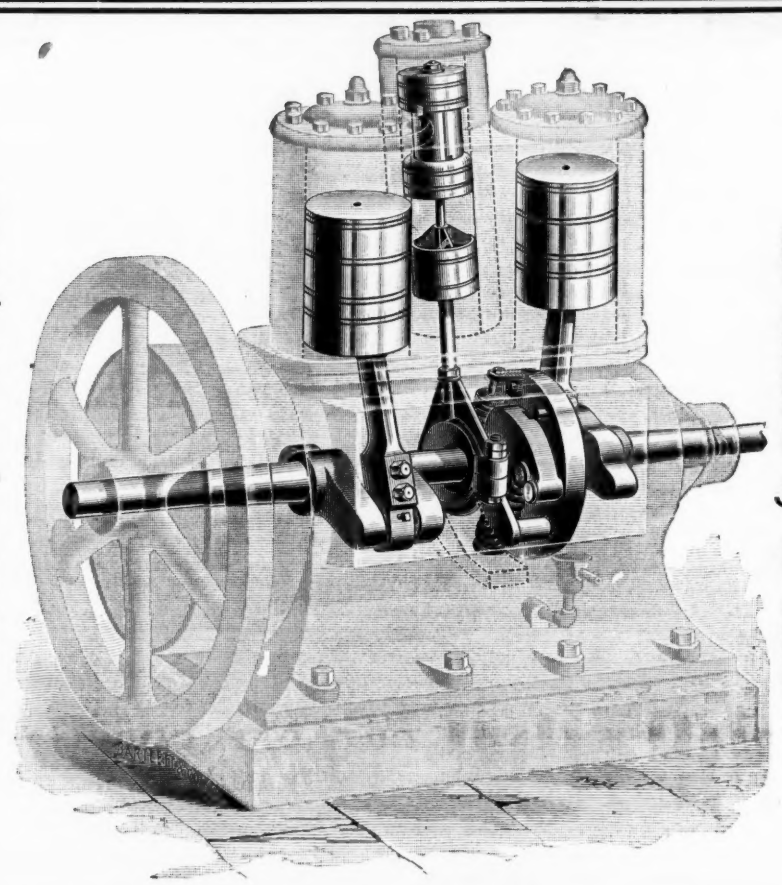
BUILD Water Works, ENGINES AND Steam Pumping MACHINERY.



SEND FOR CATALOGUE No. 18.

IF YOU WANT A
SHAPER, PLANER, DRILL, LATHE OR SPECIAL MACHINERY,
WRITE TO
THE HENDEY MACHINE CO.,
SEND FOR A CATALOGUE. TORRINGTON, CONN.

Condemned by its Competitors



and Endorsed by its Users.

THE WESTINGHOUSE AUTOMATIC ENGINE.
Prices Reduced.
THE WESTINGHOUSE MACHINE CO., PITTSBURGH, PA.
Sales Department for the United States conducted by

WESTINGHOUSE, CHURCH, KERR & CO.
17 Cortlandt St., N. Y. Hamilton Building, Pittsburgh, Pa.
FAIRBANKS, MORSE & CO., Chicago Ill.
FAIRBANKS & CO., St. Louis Mo.
PARKE & LACY, San Francisco, Cal.
UTAH & MONTANA MACHINERY CO., Salt Lake, Utah.
D. A. TOMPKINS & CO., Charlotte, N. C.
IRON BAY MANUFACTURING CO., Marquette, Mich.

STEAM PUMPS for Hot or Cold, Fresh or Salt Water; for Oils, Naphtha, Tar; for Cane Juice, Liquors, Syrups, Scum; for Ammonia, Alkalies, Extracts, Acids; for Thick, Volatile, Viscous or Foul Liquids, etc. VACUUM PUMPS of the highest efficiency. FILTER PRESS PUMPS. Air, Gas and Acid Blowers. AIR COMPRESSORS. Etc. BUILT BY
GUILD & GARRISON, Brooklyn, N. Y.

THE CELEBRATED
HEALD & SISCO CENTRIFUGAL PUMPS
Vertical and Horizontal.

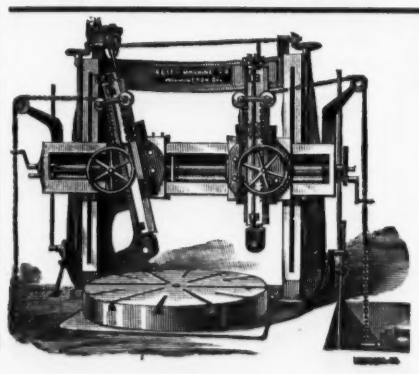
HEALD, SISCO & CO.
22 CORTLANDT ST., NEW YORK.
In Writing, Mention this Paper.

Nickel Plated Pocket Level.

2½-in. 60 cents. 3½-in. 75 cents.
By Mail on Receipt of Price.

GEO. F. BLAKE MANF'G. CO.
BUILDERS OF EVERY VARIETY OF

95 & 97 LIBERTY ST., NEW YORK. 111 FEDERAL ST., BOSTON.
WATER WORKS PUMPING ENGINES A SPECIALTY



Boring and Turning Mills
MADE BY
BETTS MACHINE CO.
WILMINGTON, DEL.

NOTE THE FOLLOWING ADVANTAGES.
Positive feeds, no friction.
Spindles entirely independent, can be moved simultaneously in opposite directions with different grades of feed.
Spindles not round, but of such shape as will allow ready adjustment for wear.
Great range of feed and abundance of power.

NICHOLSON FILE COMPANY, *Sole Mfrs. of*

FILES and RASPS Having the Increment Cut, also, FILERS' TOOLS and SPECIALTIES.

The above illustration represents a device in which files may be held for service in surface filing, and while in this condition READILY SPRUNG, in order to give at the will of the operator, more or less convexity to the working face of the file. It does away with unusual care to obtain a true convexity or "belly" to file sides, and in fact renders great service by enabling the operator to utilize the file to its full capacity.

SURFACE FILE HOLDER No. 4, Adapted to Hold Files 12, 13 14 in. Long.
" " " " 5, " " " 14, 15, 16 "

MANUFACTORY AND OFFICE - - PROVIDENCE, R. I., U. S. A.

THE NEW "GRESHAM" PATENT AUTOMATIC RE-STARTING INJECTOR

"Invaluable for use in Traction, Farm, Portable Marine and Stationary Boilers of all kinds. No handles required. Water supply very difficult to break. Capability of re-starting automatically, immediately after interruption to feed from any cause."

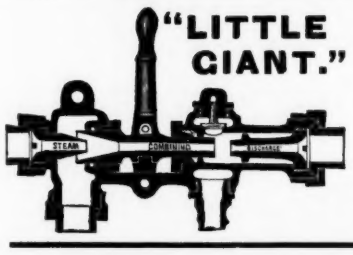
SEND FOR CATALOGUE. RELIABLE AND CHEAP.

Sole Manufacturers in the United States and Canada.

NATHAN MANUFACTURING CO.

92 & 94 LIBERTY ST., - - - NEW YORK.

"LITTLE GIANT." THE BEST INJECTOR,



For Feeding all Steam Boilers.

RUE'S EJECTOR,

Superior to all others for Raising and Forcing Water and other Liquids.

RUE M'F'G. CO., PHILA., PA.

CATALOGUES FREE.

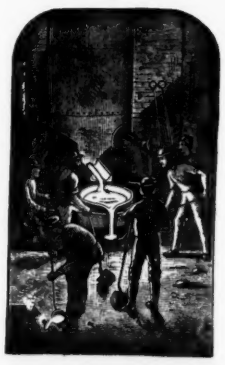
Established in 1874.

CLEVELAND TWIST DRILL CO.

24 and 26 West Street, Cleveland, O.
101 Chambers Street, New York.
85 Queen Victoria St., London, Eng.

FRICTION CLUTCH PULLEYS AND CUT-OFF COUPLINGS.

JAS. HUNTER & SON, North Adams, Mass.



T. SHRIVER & Co's IRON FOUNDRY,

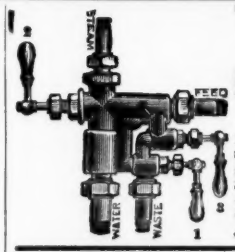
333 East 56th St., NEW YORK.

Contracts Solicited for Machinery Castings in regular supply.

ROOTS' NEW ACME HAND-BLOWER.

For Blacksmiths, etc. Slow Speed. Positive Blast. Is Durable Compact and Cheap, also Portable Forges, Tuyere Irons and Foundry Blowers.

P. H & F. M. ROOTS, Mfrs.
CONNERSVILLE, IND.
S. S. TOWNSEND, Gen. Agt., } 22 CORTLANDT ST., NEW YORK.
COOKE & CO., Selling Agts., }
Please Mention This Paper.



The BEST in the World
Sustained by the U. S. Courts.
—The—
Duplex, Union and Alert INJECTORS.

Simple in construction Easily taken apart. No springs to get out of order Always ready. Always delivers water hot to boiler Thousands in use and demand increasing. Send for Catalogue, to

JAS. JENKS & CO., Detroit, Mich

MANUFACTURING BUSINESS for SALE

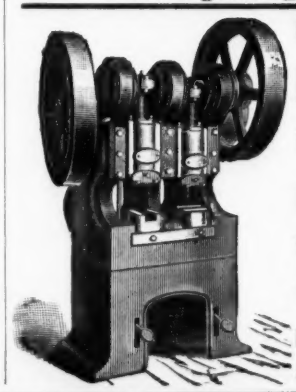
A desirable and well-established manufacturing business, making from twelve to fifteen thousand dollars per annum, is offered for sale, because of the advanced age of the proprietor. Parties desiring to purchase may apply to

ROGERS, LOCK & MELBORN,
28 Erie Street, Buffalo, N. Y.

ECONOMICAL STEAM BOILERS

A SPECIALTY.

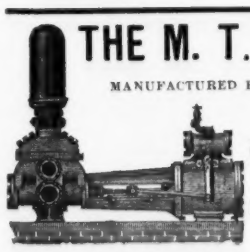
SEND FOR PRICES. **Pond Engineering Co.** ST. LOUIS, MO.



BEAUDRY'S DUPLEX Power Press

COMBINING PRESS, SHEARS AND PUNCH.

BEAUDRY & CO.
(Formerly of Beaudry's Upright Power Hammer.)
Sole Manufacturers.
Also manufacturers of HARD COAL HEATING FORGES.
Room 4, MASON B'DG, 70 KILBY ST., Boston, Mass.



THE M. T. DAVIDSON IMPROVED STEAM PUMP,

MANUFACTURED BY **DAVIDSON STEAM PUMP COMPANY.**

WARRANTED THE **BEST PUMP** MADE FOR ALL SITUATIONS.

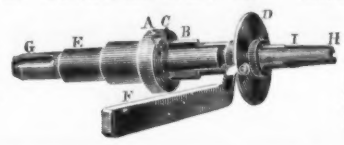
PRINCIPAL OFFICE, No. 77 LIBERTY STREET, N. Y.
NEW ENGLAND OFFICE, 51 OLIVER STREET, BOSTON, MASS.

LECOUNT'S NEW EXPANDING MANDREL.

Amateur's Size.

Taking anything from 3/8 to 1 inch inclusive.
Price,..... .....$5.00

Patented Dec. 25, 1877.



Machinist's Size.

No.		PRICE
1	½ to 1 in.	$10
2	1 " 1½ "	14
3	1½ " 2 "	18
4 (with screws)	2 " 3 "	32
5 " "	3 " 4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.

PARK MFG. CO.

MANUFACTURER OF

34 Beach Street, Boston, Mass.

The Park Injector,

EJECTORS AND JET APPARATUS.

LATHE CHUCKS, "THE SWEETLAND CHUCK," DRILL CHUCKS, BELT CLAMPS.

MACHINISTS' TONGS, PIPE CUTTERS AND WRENCHES. WRITE FOR DISCOUNTS.

OUR

SPECIAL MACHINERY, DIES, TOOLS, &c. SUB-PRESS DIES A SPECIALTY.

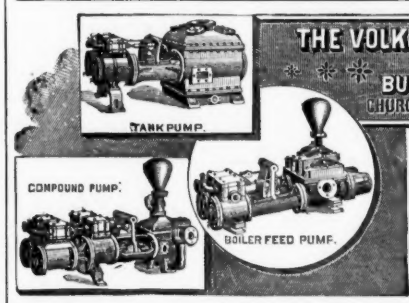
-alogue Mailed on Application.
THE HOGGSON & PETTIS MFG. CO., New Haven, Ct.
Established 1849.

STEEL STAMPS, STEEL LETTERS, FIGURES, STENCILS, BRASS CHECKS, &c.

VOLNEY W. MASON & CO.,
Friction Pulleys, Clutches and Elevators,
PROVIDENCE, R. I.

THE VOLKER & FELTHOUSEN MFG. CO.

MANUFACTURERS OF
BUFFALO DUPLEX STEAM PUMPS.
CHURCH BIRDSALL & MECHANIC STS BUFFALO N.Y.



For Sale at Factory Prices by

A. Aller, New York; S. C. Nightingale & Childs, Boston; Henry I. Snell, Philadelphia; Thos. J Bell & Co., Cincinnati; Shaw, Kendall & Co., Toledo; The George Worthington Co., Cleveland; Goulds & Austin, Chicago; Kennedy & Pierce Machinery Co., Denver, Col.; Sheriff & Ashworth, Pittsburgh, Pa.; Jos. Baur, Manistee, Mich.; Jas. Jenks & Co., Detroit, Mich.; Wickes Bros. East Saginaw; Adolf Leiteit, Grand Rapids E. F. Osborne & Co., St. Paul, Minn; Rundle, Spence & Co., Milwaukee, Wis., Joshua Hendy Machine Works, San Francisco; Flynn & Emrich, Baltimore, Md.; Forbes Liddell & Co., Montgomery, Ala.; Bailey & Lebby, Charleston, S. C.; Pond Engineering Co., St. Louis and Kansas City, Mo.; O. B. Goodwin, Norfolk, Va.; Columbus Supply Co., Columbus, O.

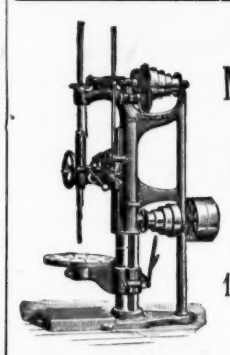
Hall STEAM PUMP CO., Steam

WHAT USERS THINK OF THE

I take pleasure in stating that the Hall Duplex Pumps put in by you in the Apartment House of John N. Stearns, 73d Street and 4th Avenue, have proved satisfactory beyond my expectations. One supplies water for house purposes and the other for running two Crane's patent passenger elevators. For ease in working, simplicity of construction and economy in the use of steam, I believe it to be the best pump in the market.

F. CARLES MERRY, Arch't, 150 Broadway, N. Y.

Duplex 91 LIBERTY STREET NEW YORK. Pump.



FITCHBURG Machine Works,

Manufacturers of

METAL-WORKING MACHINES.

Office and Works,
13 to 21 Main Street,
FITCHBURG,
MASS.

SEND FOR CATALOGUE (E.)

SHEPARD'S NEW $60 SCREW-CUTTING FOOT LATHE.

Gap Lathe, $125.

Foot and Power Lathes, Drill Presses, Scroll-saw Attachments, Chucks, Mandrels, Twist Drills, Dogs, Calipers, etc.
Lathes on trial. Lathes on payment.
Send for catalogue of Outfits for Amateurs or Artisans.

Address, H. L. SHEPARD, Agent, 134 E. Second St., Cincinnati, O.

WALKER'S TOOL HOLDER.

For holding drills and reamers for lathe work. Prevents breaking or slipping. Can also be used for drilling and reaming holes by hand, and for reaming holes under drill presses, etc. Made with double handle, when required.

WALKER MFG. CO.,
CLEVELAND, OHIO.

HENRY CAREY BAIRD & CO.,
Industrial Publishers, Booksellers and Importers,
810 Walnut St., Philadelphia.

☞ Our Catalogue of Practical and Scientific Books, 96 pages 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

STEAM HEATING FOR BUILDINGS,

Or, Hints to Steam Fitters. Being a description of Steam Heating Apparatus for Warming and Ventilating Private Houses and Large Buildings, with Remarks on Steam, Water and Air in their Relations to Heating. To which are added useful miscellaneous tables. By Wm. J. Baldwin. Eighth edition, revised and enlarged. With many illustrative plates. 12mo, cloth, $2.50.

"Mr. Baldwin has supplied a want long felt for a practical work on Heating and Heating Apparatus."—*Sanitary Engineer.*

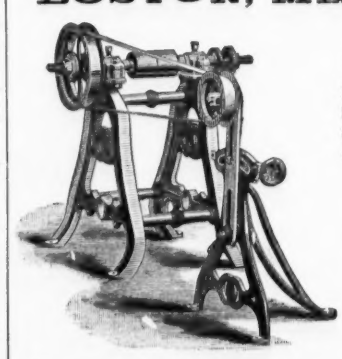
JOHN WILEY & SONS, 15 Astor Pl., N. Y.
Publishers of Scientific and Industrial Works.

*** *Will be mailed and prepaid on the receipt of the price. Catalogues and Circulars free by mail.*

UNION STONE COMPANY,

38 & 40 Hawley St.,

BOSTON, MASS.



FOR BELTS	
1½	in. wide.
2	" "
3	" "
4	" "

Wooden Polishing Wheels, All Sizes to Order.

Wooden Wheel Polishing Machine and Floor Belt Attachment combined. Can furnish either separately, if desired.

Endless Polishing Belts made to Order of any Length and Width.

SEND FOR CATALOGUE.

H. W. JOHNS

PRICE REDUCED.

ASBESTOS ROOFING

FIRE AND WATER-PROOF BUILDING FELT, FIRE-PROOF PAINTS, STEAM PACKINGS, BOILER COVERINGS, ETC.

Samples and descriptive Price List free by mail.

H. W. JOHNS M'F'G CO., 87 MAIDEN LANE, N. Y.

WORTHINGTON —HIGH DUTY— Pumping Engine

—FOR—

WATER WORKS

OVER 100,000,000 DUTY

—GUARANTEED—

SEND FOR RECENTLY ISSUED PAMPHLET

HENRY R. WORTHINGTON
NEW YORK CITY.

SAFE BOILERS
HARRISON SAFETY BOILER WORKS.
PHILADELPHIA, PA.
ECONOMICAL
MERITS PROVEN
DURABLE
20 YEARS RECORD

ADOPTED.
THE
Babcock & Wilcox Boiler.

[Copy] CONSTRUCTION COMMITTEE FOR
Edison Electric Illuminating Co. of New York.

Committee.
E. H. Johnson,
C. H. Coster,
C. E. Chinnock,
John I. Beggs.

ENGINEER'S OFFICE,
Room 53, 16 Broad Street,
NEW YORK, July 28th, 1887.

Engineer, J. H. Vail.

THE BABCOCK & WILCOX CO., 30 Cortlandt Street, City.

GENTLEMEN:—You are hereby notified that your proposals are accepted for water tube boilers, to be used in the three new stations of the Edison Electric Illuminating Company of New York City.

The horse-power required in these three stations will aggregate 8,700 horse-power.

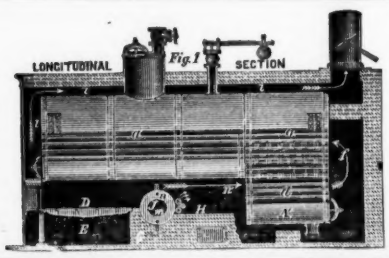
I enclose you herewith contracts in triplicate, covering the boilers now required for station in 26th street.

Please execute contract and return two copies to me.

Yours truly,
[Signed] J. H. VAIL,
Chief Engineer.

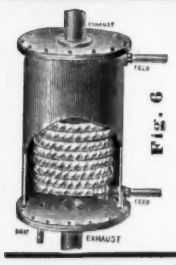
Enclosures.

This System of Feed Water Heater is the Best
AND THE
LOWE
is the simplest
HEATER
on the system.
Has Straight Tubes
with reliable provision for expansion and will
HEAT
AND
Purify the Water
EQUAL TO ANY
With same Feet of Heating Surface
AND
WEAR the LONGEST.
Send for description and Histories of Boilers and Feed Water Heaters, to
Bridgeport Boiler Works, Bridgeport, Conn.

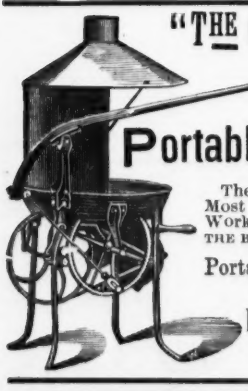


The Bate STEAM GENERATOR
Generates steam rapidly and economically. Constant circulation of water. Easily Cleaned. Furnace produces perfect combustion. Best evaporative duty. Material and workmanship A1. Large number in use.
Infringements Rigorously Prosecuted.
WM. T. BATE & SON,
Sole Manufacturers,
CONSHOHOCKEN, PENNA.

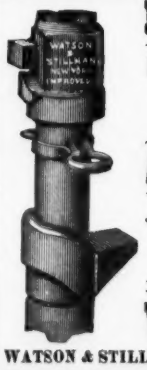
NEWBURGH STEAM BOILER WORKS. P. DELANY.
NEWBURGH, N.Y.
MANUFACTURER OF
STEAM BOILERS OF EVERY DESCRIPTION
CARRY A LINE OF BOILERS IN STOCK FOR IMMEDIATE DELIVERY.



THE WAINWRIGHT M'F'G CO.
65 and 67 Oliver Street, Boston, Mass.,
MANUFACTURERS OF
Corrugated Tubing, Feed-Water Heaters,
Condensers, Filters, Expansion Joints, Radiators, and Water Purifying Plants for Steam Boilers.
SEND FOR ILLUSTRATED CATALOGUE.



"THE ONLY PERFECT"
BUFFALO
Portable Forges.
The Lightest, Strongest, Most Durable, Easiest Working, and in every way THE BEST
Portable Forge Made.
Buffalo Forge Co.,
BUFFALO, N. Y.



HYDROSTATIC MACHINERY,
PRESSES,
PUMPS,
PUNCHES,
ACCUMULATORS,
JACKS,
VALVES,
FITTINGS,
VAULT ELEVATORS, &c., &c.
WATSON & STILLMAN, 204-210 East 43d St., N. Y.

CRANK PLANERS
Superior Design & Workmanship, Extra Heavy (1500 lbs.)
DOWN, ANGULAR AND CROSS-FEED,
TO PLANE 12x16x15.
THE R. A. BELDEN CO., DANBURY, CT.

American Twist Drill Company's
PATENT CHUCK JAWS.
Three sizes. Price per set of 4 Jaws, $40, $48, $56. Bolted to lathe face plates, they make best and cheapest chuck in the world. Address orders, Laconia, N. H
HILL, CLARKE & CO., Boston and St. Louis.
MANNING, MAXWELL & MOORE, N. Y. City.
TALLMAN & McFADDEN, Philadelphia, Pa.
or WM. BINGHAM & CO., Cleveland, Ohio

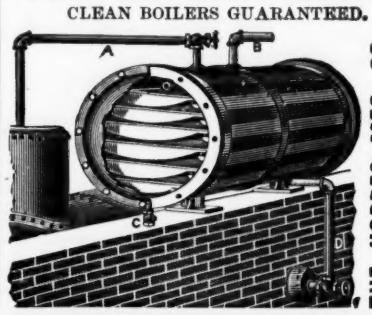
The Waterhouse Electric & M'f'g Co.,
OFFICERS AND DIRECTORS.
ASA S. COOK, President. CHAS. P. HOWARD, Secretary, J. L. H. & CO.
S. W. BISHOP, Vice President. S. O. PRENTICE, Attorney.
F. A. PRATT, President The Pratt & Whitney Co.
CHAS. E. BILLINGS, Pres. The Billings & Spencer Co. JAS. A. CHURCH, N. Y.
GEO. M. BOND, Mgr Gauge Dept. The P. & W. Co. A. G. WATERHOUSE, Elec'n.
FRANK G. WATERHOUSE, Gen'l Mgr. CHAS. E. CHAPIN, Secretary.
The Waterhouse System of Arc and Incandescent Lighting is of acknowledged superiority. Send for Catalogue.
FACTORY, COLT'S WEST ARMORY, HARTFORD, CONN.

JENKINS BROS.' VALVES
Stand at the head, are specified by architects, used in the principal public buildings, and always referred to by steam fitters when the best is called for. The Valves contain all the late improvements—using the **genuine Jenkins Disc.** Don't be deceived into buying a cheap and inferior valve, using a worthless disc, but insist on having **Jenkins Bros. Valves,** containing a **Jenkins Disc** and the only disc that will stand **high pressure** of steam. By so doing, you avoid paying for the experiments of others—and get the **best.**
JENKINS BROS., 71 John Street, N. Y.; 105 Milk Street, Boston; 13 So. Fourth Street, Philadelphia; 54 Dearborn Street, Chicago.

WESTCOTT CHUCK CO., Formerly Oneida Steam Engine & Foundry Co., ONEIDA, N. Y.
Manufacturers of all kinds of
LATHE AND DRILL
CHUCKS.
Send for Catalogue.
Under Westcott's Patent.

Capacity Little Giant Improved.		
No. 00	holds 0 to	¼ inch.
" 0	" 0 to	½ "
" 1	" 0 to	⅝ "
" 2	" 0 to 1	"
" 2½	" 0 to 1	"

THE NEW HOPPES LIVE STEAM FEED-WATER
Heater and Lime Extractor.
CLEAN BOILERS GUARANTEED.



THE HOPPES MFG. CO.
SPRINGFIELD, O.
—Send for Catalogue D.—

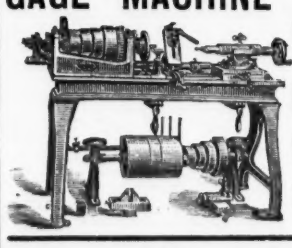
A Complete Cutting-off Machine, $4.00
Larger ones which cut to 2 in. $8.00
SENT ON TRIAL.

STERLING ELLIOTT, Newton, Mass.

"CUSHMAN" CHUCKS
Are guaranteed to be right in all respects. Ask to see them at your dealer's, or write direct to the factory. Respectfully,
THE CUSHMAN CHUCK CO.,
HARTFORD, CONN.

J. A. FAY & CO. CINCINNATI, OHIO, U.S.A.
BUILDERS OF IMPROVED
WOOD-WORKING MACHINERY
Embraces nearly 400 Machines for
PLANING & MATCHING
Surfacing, Moulding, Tenoning, Mortising, Boring, and Shaping, etc.
Variety and Universal
WOOD WORKERS.
Band, Scroll and Circular Saws, Resawing Machines, Spoke and Wheel Machinery, Shafting, Pulleys, etc. All of the highest standard of excellence.
W. H. DOANE, Pres't. D. L. LYON, Sec'y.

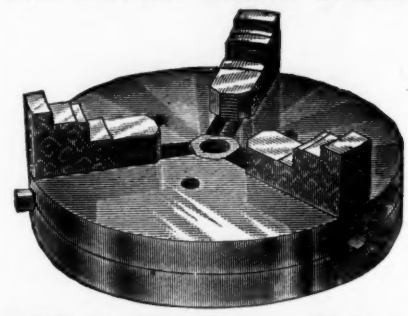
GAGE MACHINE WORKS,
Waterford, N. Y.
Manuf'r's of
FOX, TURRET AND SpeedLathes AND Brass Finishers' TOOLS.



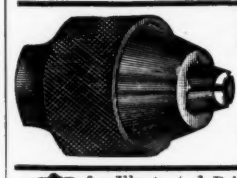
Arthur B. Phillips, Machinist, WHITMAN, MASS.
Manufacturer of
Atwood's Patent Power Matcher and Gluer and Stafford & Whipple's Patent Planer and Surface Gauge.
Light Machinery of all kinds Built at Short Notice.
Estimates furnished. Correspondence solicited.

THE NATIONAL
FEED-WATER
HEATER.
A brass coil heater supplying feed water at 210° to 212° Fahrenheit by use of exhaust steam.
Our prices are low and reasonable, and we aim to supply the *cheapest, best and most effective Heater in the market.* Sixteen sizes. 10 H.P., $20; 100 H. P., $150; 500 H. P., $600. Iron, Brass and Copper Coils and Bends made to order. Circulars and price lists sent on application.
National Pipe Bending Co.
NEW HAVEN, CONN.

ESTABLISHED 1851.
The Horton Lathe Chuck.

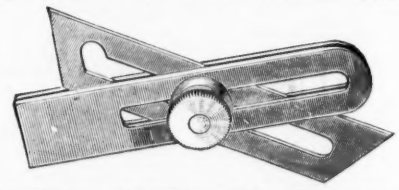


THE E. HORTON & SON CO.
Canal St., Windsor Locks, Conn., U. S. A.



Almond Drill Chuck
Sold at all Machinists' Supply Stores.
T. R. ALMOND,
83 & 85 Washington St., Brooklyn, N. Y.

SEND for Illustrated Price List of *Fine Tools,* manufact'd by Standard Tool Co., Athol, Mass.



Any Tool we make will be sent by mail or express to any address, all charges prepaid, on receipt of price.

STANDARD PUNCHES FOR

IRON & STEEL PLATES.

PATENTS
R. G. Du Bois, Patent Att'y, 916 F St., Washington, D. C. Good references. Send for pamphlet.

CHARLES MURRAY
ENGRAVER ON WOOD
58 ANN ST. NEW YORK

Special Pulley Machines.
If you want to bore and turn pulleys and not lose money, write for particulars of our
PULLEY MACHINES.
Prices one-third cheaper than similar machines of other makers.
The Newark Machine Tool Works,
NEWARK, N. J.

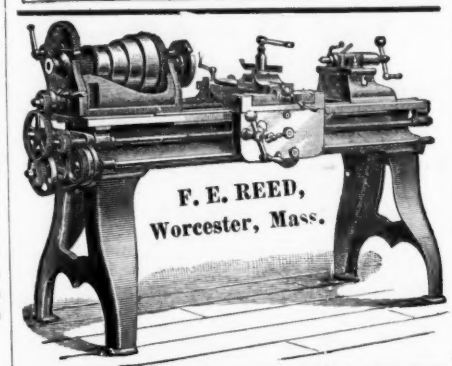
Morse Twist Drill and Machine Comoany, New Bedford, Mass.
Manufacturers of Morse Patent Straight-Lip Increase Twist Drills.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

STEEL BALLS
FOR ANTI-FRICTION BEARINGS,
OF BEST CAST STEEL.
HARDENED GROUND & BURNISHED.
3-16" to 3" Diameter.
Samples and Prices on application.
SIMONDS ROLLING-MACHINE CO.
FITCHBURG, MASS.

WELDLESS STEEL TUBES — QUICK OPENING GATE VALVE — COLD DRAWN
SMOOTH INSIDE & OUT.
JOHN S. LENG, 4 Fletcher St N.Y.

CALUMET AND HECLA MINE,
CALUMET, MICH.,
June 14th, 1887.
J. E. LONERGAN & Co.,
211 Race St., Phila., Pa:
We have received and applied your Pop Safety Valve. Up to this date it is giving excellent satisfaction. It holds the steam to within one pound of the working pressure. If it holds out as well as it started off, we will find it to be the best valve the writer has ever used. We shall undoubtedly require more before long
L. S. WOODBURY,
2D ASS'T SUP'T.



ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills, and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 LIBERTY STREET, NEW YORK.

S. Ashton Hand Mfg. Co., Toughkenamon, Pa.

Hand's Twist Drill Grinding Attachment.
Readily attached to any grindstone, emery or cutter-grinder. Grinds right and left hand drills from 3/8" diam. down to smallest sizes
PRICE $20.

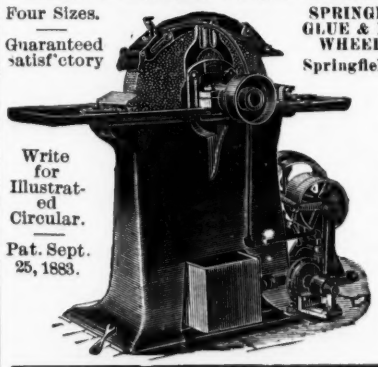
SHAPING MACHINES
FOR HAND AND POWER.
6", 3' and 10' Stroke.
Adapted to All Classes of Work to their Capacity.
Circulars Furnished.
BOYNTON & PLUMMER,
WORCESTER, MASS.

UPRIGHT DRILLS
A SPECIALTY.
ALL SIZES
—WITH—
Patent Quick Return
—AND—
Latest Improvements.
For Catalogues and Prices, address,

BICKFORD DRILL CO.
Cor. Front & Pike Sts.
CINCINNATI, O.

DIXON'S
SILICA GRAPHITE
BOILER-FRONT AND SMOKE STACK PAINT.
WILL LAST FOR YEARS
JOS. DIXON CRUCIBLE CO.
JERSEY CITY, N. J.

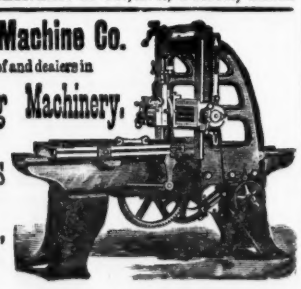
EMERY-WHEEL TOOL GRINDER.
Four Sizes.
Guaranteed satisf'ctory
SPRINGFIELD GLUE & EMERY WHEEL CO.,
Springfield, Mass



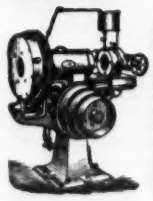
Write for Illustrated Circular.
Pat. Sept. 25, 1883.
Water runs on wheel and prevents heating.

—OUR—
NEW CATALOGUE OF TOOLS
and Supplies sent free to any address on receipt of Ten Cents in stamps (for postage).
CHAS. A. STRELINGER & CO., Wood Ave., Detroit, Mich.

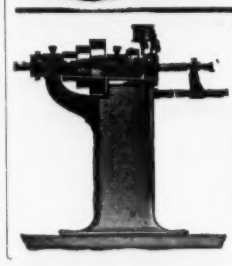
L. W. Pond Machine Co.
Manufacturers of and dealers in
Iron Working Machinery.
IMPROVED IRON PLANERS
A Specialty.
140 Union St., WORCESTER, MASS.



NEW YORK AGENTS.
FRASER & ARCHER,
NEW AND SECOND-HAND MACHINERY,
SHAFTING, HANGERS AND PULLEYS,
121 CHAMBERS STREET.



"ECLIPSE" Pipe-Cutting Machines
FOR HAND OR POWER.
Don't you have sufficient Pipe-Work about your Mill, Factory, or Shops to make a powerful, convenient and very compact Pipe-Cutting Machine soon pay for itself, providing it could be had at a moderate price? Mention this paper and write us for particulars.
PANCOAST & MAULE,
Philadelphia, Pa.
Made in Three Sizes, Cutting Pipes ¼ to 6 Inch.



William Barker & Co
Manufacturers of
IRON AND BRASS
—WORKING—
MACHINERY
140 & 142 E. Sixth Street, N'r Culvert, Cincinnati, O.
Send for circulars and prices.

HERRICK & COWELL,
Manufacturers

Drill Presses,
POWER AND FOOT
PRESSES,
Hand Lathes,
Paper Box and Special Machinery.
37 Artisan St., New Haven, Conn
Send for Catalogue

D. SAUNDERS' SONS
MANUFACTURERS OF THE ORIGINAL
TRADE I. X. L. MARK.
Pipe Cutting and Threading Machine.
BEWARE OF IMITATIONS.
None genuine without our Trade-mark and Name.
STEAM AND GAS-FITTERS' HAND TOOLS.
Pipe Cutting and Threading Machines, for Pipe Mill Use, a Specialty.
Send for Circulars. YONKERS, N. Y.

REGISTERED TRADE MARK — ELIAS HOWE JR. — INVENTOR & MAKER NEW YORK U.S.A. — EMBEDDED IN THE MACHINE

THE
New Howe Mfg. Co.
BRIDGEPORT, CONN.
Mfrs. of Sewing Machines
Light and Medium Weight
Gray Iron Castings
OF ALL DESCRIPTIONS TO ORDER; ALSO,
TOOL MAKING, JAPANNING —AND— PLATING.
Correspondence Solicited.

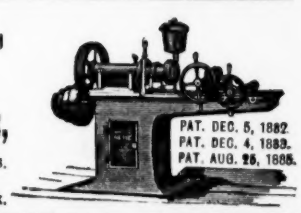
MACHINISTS' SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

BEVEL GEARS,
Cut Theoretically Correct.
For particulars and estimates apply to
BREHMER BROS.
Machinists,
440 N. 12th St., Philadelphia, Pa.

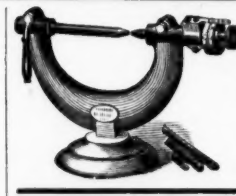
SMITH'S PATENT CALCULATOR
Being, in 10x3¼x1⅛ inches, a complete pocket book and instantaneous calculation slide for Architects, Naval Architects, Mechanical, Civil, Military and Electric Engineers. Promptly and easily used with the mere knowledge of decimal fractions. Complete with logarithms, sines and tangents, $3.50. Without sines and tangents, $2.50 and $1.50. Will be mailed on the receipt of price.
R. C. SMITH, C. E., No 1 Broadway, New York.

THOS. H. DALLETT & CO.
13th & Buttonwood Sts., PHILA. PA
Manufacturers of
PATENT
Portable Drilling Machines,
VERTICAL DRILLS,
Radial Drills, Multiple Drills,
HAND DRILLS.
SEND for ILLUSTRATED CATALOGUE.

ACME MACHINERY CO.,
CLEVELAND, OHIO.
Manufacturers of
"ACME"
Single & Double Automatic Boltcutters,
cutting from 3-8 in. to 6 in. diameter.
Also SEPARATE HEADS AND DIES.
Send for Catalogue and Discounts.
Agents, Manning, Maxwell & Moore, New York.



Sterling Emery Wheel Co.
MANUFACTURERS,
West Sterling, Mass.
AGENCIES:—Frank J. Scott, Boston; N. Y. Supply Co., New York; E. L. Hall & Co., Phila.; Marinette Iron Works Co., Chicago; Ripley & Bronson, St. Louis; Brown & King, Atlanta, Ga.; Columbus Supply Co., Columbus, O.



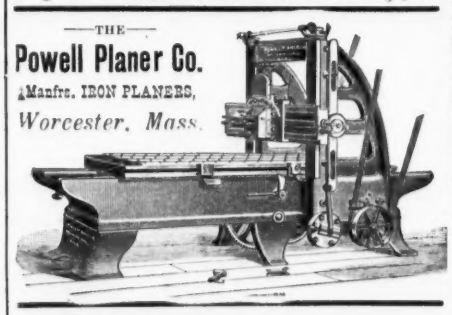
SWEET'S
Measuring Machine.
The only micrometer that will not lose its accuracy by wear
Satisfaction Guaranteed.
SYRACUSE TWIST DRILL CO.
Syracuse, N. Y.

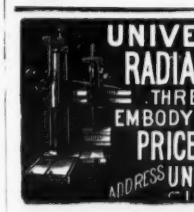
MACHINERY
For Reducing and Pointing Wire.
Especially Adapted to pointing wire rods and wire for drawing.
For Machines or information, address the manufacturer.
S. W. GOODYEAR, Waterbury, Ct.

WOOD-WORKING MACHINERY

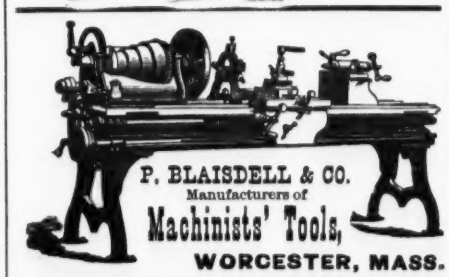
For Planing Mills, Furniture, Chair and Cabinet Factories, Cabinet Works and General Wood-Working. Send Stamp for Illustrated Catalogue to
Rollstone Machine Co.
45 WATER ST., FITCHBURG, MASS.

—THE—
Powell Planer Co.
Manfrs. IRON PLANERS,
Worcester, Mass.





UNIVERSAL RADIAL
RADIAL DRILLING MACHINES
THREE DESIGNS. SIX SIZES.
EMBODY ALL DESIRABLE FEATURES
PRICES $450.00 & UPWARD
ADDRESS UNIVERSAL RADIAL DRILL CO
CINCINNATI, OHIO, U.S.A.



P. BLAISDELL & CO.
Manufacturers of
Machinists' Tools,
WORCESTER, MASS.

FORBES & CURTIS,
BRIDGEPORT, CT.,
Manufacturers of
The Forbes Pat. Die Stocks,
Power Pipe Cutting and Threading Machines, Cutting-off Machines, Ratchet Drills, Special Machinery, etc., etc.
WRITE FOR CATALOGUE.
Mention Paper.

PECK'S PAT. DROP PRESS.
NEW HAVEN
BEECHER & PECK, CONN.
DROP FORGINGS OF IRON OR STEEL
BEECHER & PECK, NEW HAVEN CONN.

PRESSURE REGULATORS

Ours are used and recommended by the leading pump manufacturers.

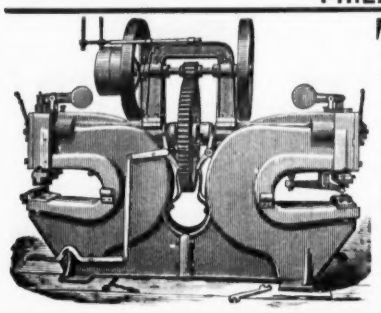
OUR REDUCING VALVE
will not "chatter" and will maintain an even steam or water pressure as low as one pound.

JENKINS BROS., New York & Chicago, Ag'ts.
MASON REGULATOR CO., 22 CENTRAL ST., BOSTON.

HIGH SPEED POWER TRAVELING CRANES.

We are now prepared to build HIGH SPEED POWER TRAVELING CRANES for any capacity of load, any length of runway and any width of span, with one or with two trolleys on the bridge. These trolleys to work either slow or fast, together or independently, in like or in opposite directions, horizontally or vertically, while the bridge can be traversing slow or fast at the same time in either direction. The speeds of bridge on runway are *100 feet and 200 feet per minute;* the speeds of trolleys on bridge are *50 feet and 100 feet per minute;* and there are four hoisting speeds *of 5, 10, 20 and 40 feet per minute;* all can be varied quickly without the least shock or jar from zero to maximum or to any intermediate speed. *The load is always automatically sustained, thus avoiding absolutely the great danger and anxiety which are inseparable from the use of those Cranes which require the operator to apply the brake.* We have had one of these Cranes of 26 tons capacity in constant use in our foundry for nearly two years, and we offer them with full confidence for the greatest range of service. We invite the correspondence of parties interested in the subject.

WM. SELLERS & CO., Incorporated,
PHILADELPHIA, PA.

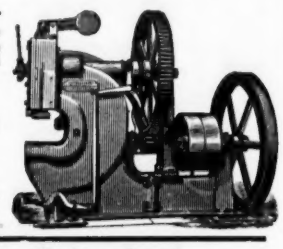


THE LONG & ALLSTATTER CO. Hamilton, OHIO.

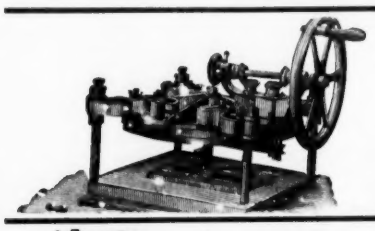
Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven

Punches and Shears.

Over 300 Sizes.
ALSO,
Power Cushioned Hammer.



Send for new Catalogue.

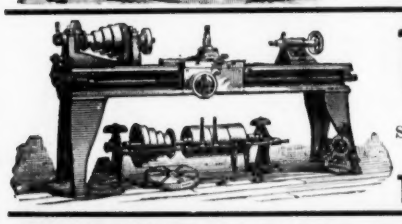


Patent Portable Valve Seat Rotary Planing Machine.

Will Plane off the Valve Seats of Locomotive and other Engines without the use of files or scrapers.

Circulars with full description on application.

PEDRICK & AYER, - Philadelphia, Pa.



16" Engine Lathes

NEW DESIGNS—LATEST IMPROVEMENTS—SIMPLICITY OF CONSTRUCTION—WORKMANSHIP OF THE BEST.
Send for Cuts and Prices.

The Muller Machine Tool Co. Eighth & Evans Sts., CINCINNATI, O.

REMOVED

On or about June 1st

H. BICKFORD,

will remove his business to

LAKE VILLAGE, N. H.,

into new shops fitted up with new and latest improved tools, especially adapted for manufacturing Boring and Turning Mills which will be made an exclusive specialty, 4-5-6 and 8 ft. Swing.

Iron and Steel

DROP FORGING

Of Every Description, at Reasonable Prices.

THE R. A. BELDEN CO., DANBURY, CT.

PATENT UNIVERSAL SCREW-CUTTING CENTER. DEPTH, ANGLE AND

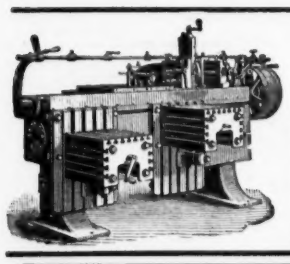
J. WYKE & CO., TWIST DRILL GAUGE

Fine Machinists' Tools.—E. Boston, Mass.—Send for Circular

FLUOR SPAR The Best Foundry FLUX.

SEND FOR LIST OF USERS.

Evansville Spar Mining Co., Evansville, Ind.



Office of EMPIRE FOUNDRY & MACHINE WORKS,
SAN FRANCISCO, CAL.

J. RICHARDS, Esq.—We have had in constant use for past 5 years one of your PATENT PLANING MACHINES. It is the first one manufactured for sale by you, and we can say that a greater variety and weight of work has been planed on this machine than by any other standard planer, taking into consideration the size of machines and weight. Its chief merits are its adaptability and handiness for all general classes of work. We have thoroughly tried the machine and can recommend it as an indispensable tool for machine works.

October 30, 1886. SAVAGE, SON & CO.

Manufactured by E. A. WALKER, 75 Laurel St., Philadelphia, Pa.

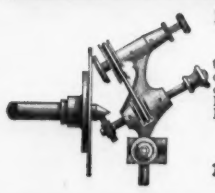
TRAUTWINE'S

CIVIL ENGINEER'S POCKET-BOOK.

"Beyond all question THE BEST practical manual for the engineer that has ever appeared."—GEORGE L. VOSE, C. E., in "Manual for Railroad Engineers."

RAILROAD CURVES. **EARTHWORK, Measurement and cost of.**

JOHN WILEY & SONS, NEW YORK. E. & F. N. SPON, LONDON.



Friction Driven Center Grinder.

A neat, simple and cheap tool to true up centers, will grind centers up quicker than they can be annealed, turned and hardened, will go on any size lathe without any adjustment.

Send for descriptive circular

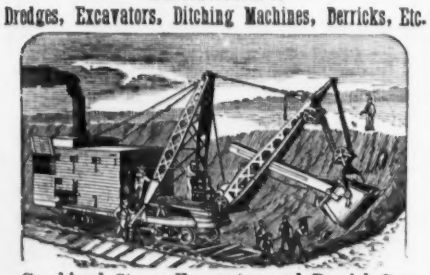
ENERGY M'F'G CO.
1115 to 1123 S. 15th Street,
PHILADELPHIA, PA.

OSGOOD DREDGE CO., ALBANY, N. Y.

RALPH R. OSGOOD, Pres. JAMES H. BLESSING, Vice-Pres. JOHN K. HOWE, Secretary and Treasurer.

MANUFACTURERS OF

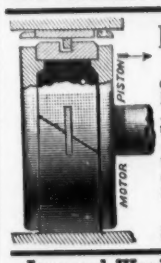
Dredges, Excavators, Ditching Machines, Derricks, Etc.



Combined Steam Excavator and Derrick Car.

WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap and Machine Screws, Studs, etc.



Brandon's Piston Ring Packing

Perfectly balanced against undue pressure in all directions. Preserves both cylinder and rings. Allows no waste by either friction or leakage. Call and see working model, expressly made to demonstrate advantages claimed. For packing or shop rights, address

JAMES BRANDON,
390 Eleventh Ave., New York.

Iron and Wood Turning Lathes and Lathe Heads, Emery Grinders, Gear Cutting attachments for Lathes, special Screws, Studs, etc.

PROGRESS ENGINE & MACHINE WORKS,
SUMMERFIELD, MD.

BEMENT, MILES & CO.,

PHILADELPHIA, PA.

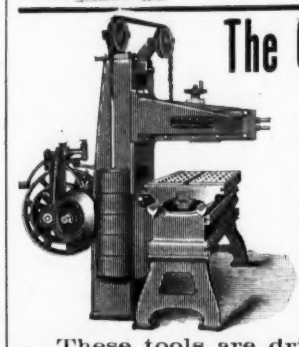
—BUILDERS OF—

METAL-WORKING MACHINE TOOLS

FOR

Railroad Shops, Locomotive and Car Builders, Machine Shops, Rolling Mills, Steam Forges, Ship Yards, Boiler Shops, Bridge Works,

ETC. ETC.



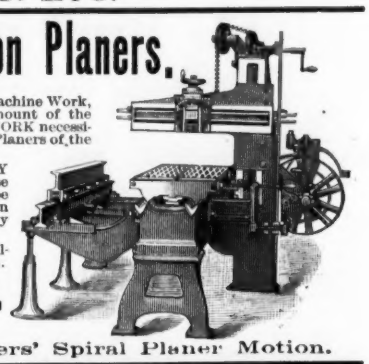
The Open Side Iron Planers.

Adapted for all classes of Machine Work, and especially for a large amount of the EXTRA WIDE and HEAVY WORK necessitating the Large and Costly Planers of the regular style.

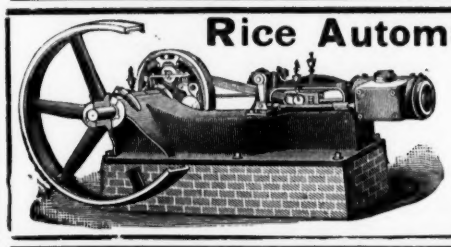
The QUALITY and QUANTITY of work performed on these Planers is GUARANTEED to be UNEXCELLED by that done on the modern tools of the very best makes.

Prices, phototypes and detailed information on application.

DETRICK & HARVEY,
Baltimore, Md.



These tools are driven by the Sellers' Spiral Planer Motion.

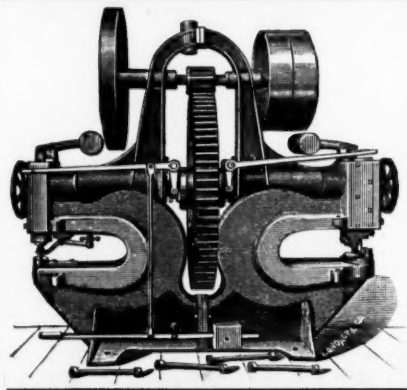


Rice Automatic Cut-off Engine

Self-Contained. Sensitive Governor.
Balanced Valve. High Speeds.
Stationary Oilers. Best Economy.

Gold Medal Cincinnati Exposition, 1884.

THE JOHN T. NOYE MFG. CO.,
BUFFALO, N. Y.



HILLES & JONES,

WILMINGTON, DEL.

PUNCHES & SHEARS

Improved Horizontal Punches.

A FULL LINE OF

BOILER-SHOP TOOLS.

Hawley's Adjustable FOUNDRY CLAMP.

Will take the place of 7 to 10 ordinary clamps, saving an hour's time each day for each moulder. Best Malleable Iron. 3 sizes. No. 1, for 7½ to 11 in. Flasks, $3 per doz. No. 2, 9 to 14 in., $5 per doz. No. 3, 13½ to 24 in., $11 per doz.

MOORE & BARNES MFG. COMPANY,
103 CHAMBERS STREET, NEW YORK.

THE SKINNER ENGINE CO.

ERIE, PA.

PORTABLE AND STATIONARY
ENGINES and BOILERS
Send for Catalogue and Prices.

SENSITIVE DRILLS.

NEW STYLES.
GREAT IMPROVEMENTS.
PATENTED GANG DRILLS.

Two, Three and Four Spindles.

The spindles in these drills are driven with a single belt made endless, no lacing, and tightener pulleys for adjusting tension provided. No more trouble from slack belts, slippage, uneven motion from lacings, or time lost taking up belts.

ALWAYS READY FOR USE

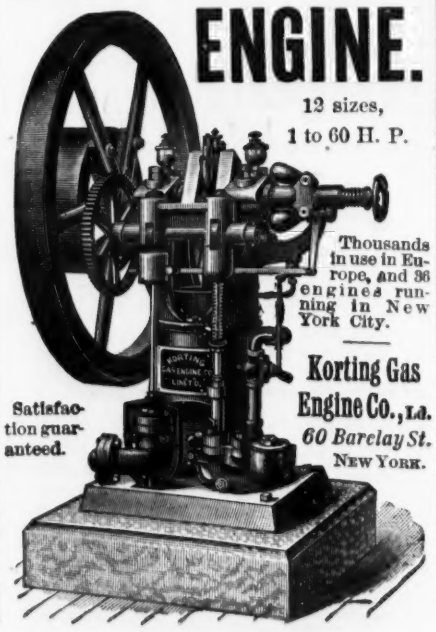
and superior to any multiple spindle drill made for drilling from .004 to 3-8 inch holes.

SINGLE SPINDLE Drills improved. Over 800 in use. Send for catalogue.

DWIGHT SLATE MACHINE CO.,
HARTFORD, CONN.

KORTING GAS ENGINE.

12 sizes,
1 to 60 H. P.



Thousands in use in Europe, and 36 engines running in New York City.

Satisfaction guaranteed.

Korting Gas Engine Co., Ld.
60 Barclay St.
NEW YORK.

E. P. B. SOUTHWORTH,
94 Exchange street, Rochester, New York.
Indicating Engineer and Mechanical Draftsman.
Correspondence solicited.

BARGAIN LIST,

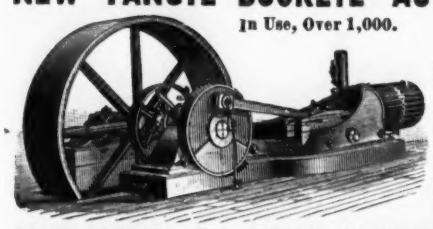
One Gray & Wood's Planer 22" wide 14' long,				Second Hand.
"	Plain Milling Machine			" "
"	Hand Planer 18"x18"x24"			" "
Two	70 H.P. Stationary Boilers			" "
One	60 "	"	"	" "
"	20 "	Coil	"	" "
"	20 "	Stationary Engine		" "
"	15 "	Vertical	"	" "
"	12 "	"	"	" "
"	10 "	"	"	" "
"	12 "	"	"	New.
"	35 "	Center Crank	"	"
"	25 "	"	"	"
"	15 "	"	"	"

" Portable Saw Mill with Saw, Belts and Fixtures complete.

S. L. HOLT & CO.
67 SUDBURY ST., Boston, Mass.

NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 1,000. 25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

SALES AGENTS: W. L. SIMPSON, 301 TELEPHONE BUILDING, 18 CORTLANDT STREET, N. Y. | N. W. ROBINSON, cor. Clinton & Jackson Sts., Chicago, Ill. ROBINSON & CARY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

THE WATTS, CAMPBELL CO.

NEWARK, N. J.

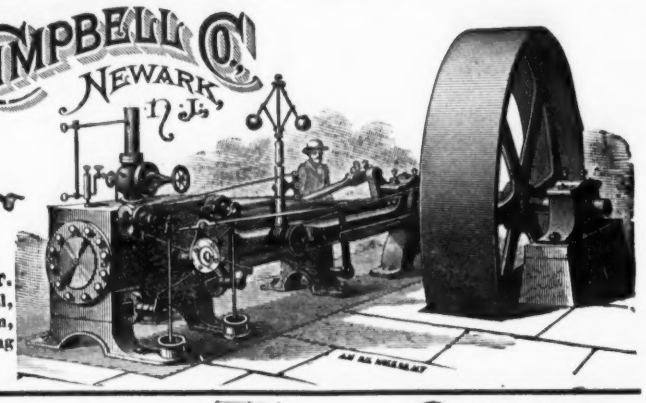
MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

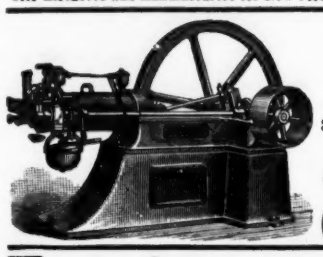
Sizes Varying From

30 to 2000 Horse Power.

Horizontal or Vertical, Direct Acting or Beam, Condensing, Non-Condensing or Compound.

Send for Circular.





"OTTO" GAS ENGINE WORKS.

SCHLEICHER, SCHUMM & CO.,

33d and Walnut Sts. PHILADELPHIA. Branch Office, 130 Washington St. CHICAGO.

OVER 20,000 ENGINES IN USE.

GUARANTEED To Consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work.

THE ALBANY STEAM TRAP CO.'S

BUCKET AND GRAVITATING

TRAPS.

Bucket.

Automatically drain the water of condensation from **HEATING COILS** and return it to the boilers whether the coils are **above** or **below** the water level in boiler, doing away with pumps and other mechanical devices for such purposes.

We also manufacture **Blessing's Patent Renewable Seat Stop and Check Valves.**—Send for Circular.

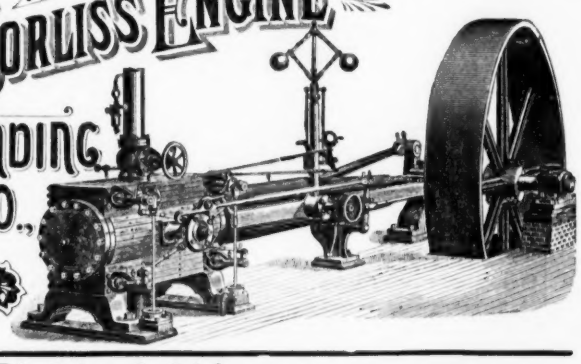
Albany Steam Trap Co. Albany, N. Y.

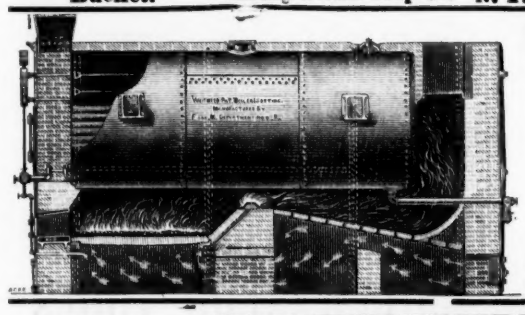
Gravitating.

THE IMPROVED FISHKILL CORLISS ENGINE

BUILT BY THE FISHKILL LANDING MACHINE CO.,

FISHKILL ON THE HUDSON, N.Y.





Weitmyer Patent Furnace,

Manufactured and Sold by

FOUNDRY AND MACHINE DEPARTMENT HARRISBURG CAR MANFG. CO.

HARRISBURG, PA.

Ide Auto. Engines. Portable and Traction Engines. Steam Road Rollers. Boilers of all descriptions.

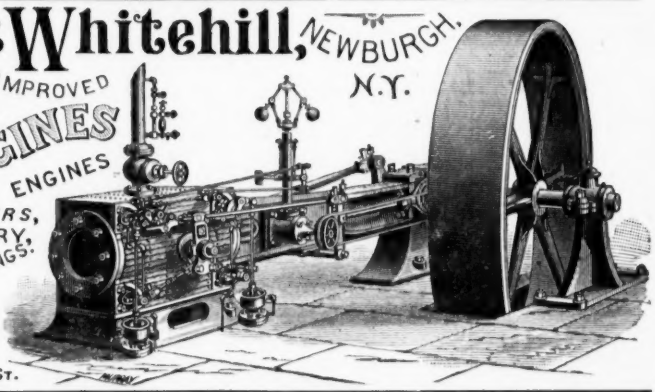
Robert Whitehill, NEWBURGH, N.Y.

MANUFACTURER OF IMPROVED CORLISS ENGINES

ALSO SLIDE VALVE ENGINES

STATIONARY BOILERS, GENERAL MACHINERY, IRON AND BRASS CASTINGS.

NEW YORK OFFICE Room 6, COAL AND IRON EXCHANGE, COR. CORTLANDT & CHURCH ST.



THE HERCULES TRADE MARK REG. U.S. PAT. OFF. JUNE 21, 1887

Section of **Copper-Wire-Sewed Light Double Belting,** specially adapted to use on cone pulleys and other hard places. Manufactured by the **PACE BELTING CO., Concord, N. H.** Also manufacturers of Staple and Special Grades of Leather Belting and the *"HERCULES"* Lacing. Send for Catalogue No. 2.

CURTIS RETURN STEAM TRAP

For returning steam, condensed under pressure, automatically into the boiler, under high or low pressure,

Manufactured by

CURTIS REGULATOR CO.

Boston, Mass.

General Agencies:
109 Liberty St., N. Y.
66 N. 4th St., Phila., Pa.
108 5th Ave., Chicago, Ill.
210 S. 3d St., Minneapolis, Minn.
707 Market St., St. Louis, Mo.

Send for Circular No. 17.

PORTER-HAMILTON ENGINE.

FOR HEAVY WORK AND LARGE POWERS.

EXTRA HEAVY DESIGN.

Send for Catalogue.

WILLIAM TOD & CO.,

YOUNGSTOWN, OHIO.

HOOPER'S 70% GRATE BAR.

Will not Warp.
Will not burn off at the ends.
Will give absolutely 70% air space.
Will give uniform combustion of fuel.

Send for Circular and Price List to

ALEXANDER TRAUD,

EAST FERRY STREET IRON WORKS, NEWARK, N. J.

MACHINE TOOLS.

NEW AND SECOND-HAND, ON HAND.

12 in. x 6 ft.	Engine Lathe,		new.
13 in. x 6 ft.	"	Ames,	"
14 in. x 6 ft.	"	Blaisdell,	"
16 in. x 6-8-10 & 12 ft.	"	Bridgeport,	new.
16 in. x 6	"	Blaisdell,	"
18 in. x 8 ft.	"	Blaisdell,	"
19 in. x 12 & 14 ft.	"	Pond,	nearly new.
20 in. x 10 ft.	"	Lathe and Morse,	fair.
20 in. x 10 & 12 ft.	"	Ames,	new.
24 in. x 10 14 & 20 ft.	"	Ames,	"
23 in. x- 12 & 14 1-2 ft.	"	Bridgeport,	"
24 in. x 16 ft.	"	New Haven,	good order.
30 in. x 14 ft.	"	W. and L. pattern,	new.
42 in. x 16 ft.	"	Ames,	"
50 in. x 24 1-2 ft.	"	New Haven,	A 1.
54 in. x 30 ft.	"	Niles,	good as new.
16 in. x 42 in.	Planer	Bridgeport,	new.
16 in. x 8 ft.	"	Pratt & Whitney,	good order.
22 in. x 4 ft.	"	Pease,	new.
22 in. x 4-5& 6 ft.	"	Powell,	"
22 in. x 5 ft.	"	Hendey,	new.
24 in. x 6 ft.	"	Hendey,	"
24 in. x 6 ft.	"	Wood and Light,	good.
26 in. x 5 ft.	"	Biglow	"
26 in. x 7 ft.	"	Brettell,	new.
30 in. x 7 ft	"	New Haven,	fair.
30 in. x 8 ft.	"	Hewes & Phillips,	new.
36 in. x 12 ft.	"	Niles Tool Works,	A 1.
12 in. Shaper,		Traveling Head,	new.
13 in.	"	Hewes & Phillips,	"
13 in. Stroke, 9 ft. Bed, Trav. Head Shaper,		Barr,	A 1.
24 in. Shaper,		Bridgeport,	new.
24 in.	"	Wolcott,	"
16-18-20-23-25-28-34 in. Drills.		30 in. Radial Drill.	
13 in. Stroke Slotter		H. & P.	new.
16 in.	"	Miles, Phila.,	A 1.
Center Bolt Cutter,			new.
50 in. Boring and Turning Mill.			A 1.
5 in. Cutting Off Machine Star.			
Fitchburg Car Axle Lathe.			
Merrill Drops, 800 lbs.			good order.
Bement 2250 lb. Steam Hammer.			

Milling Machines, Screw Machines, Slate Sensitive Drills, Gang Drills, and full line of all kinds of Machine Tools. Send for list and specify what is wanted.

E. P. BULLARD,

72 Warren Street and 62 College Place, New York.

THE NATIONAL AUTOMATIC BOLT CUTTER

"THE BEST"

PREMIUM AT EVERY EXPOSITION

CATALOGUES ON APPLICATION

BOLT HEADERS POINTERS RIVET, SPIKE HOT & COLD UPSETTERS

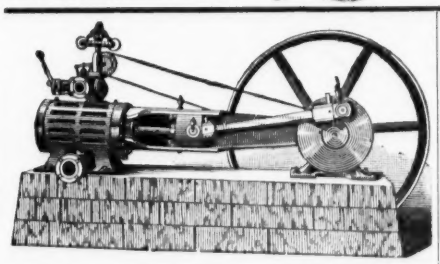
CARRIAGE BOLT MACHINERY

HOT & COLD AUTOMATIC NUT & WASHER TAPPERS OF EVERY STYLE

WIRE NAIL MACHINES

THE ONLY SPECIALISTS FURNISHING COMPLETE PLANTS IN THE U.S.

THE NATIONAL MACHINERY CO TIFFIN, OHIO, U.S.



STEARNS MFG. COMPANY,

ERIE, PA.

Engines from 15 to 400 Horse Power.

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogues.

SAW MILLS and GENERAL MACHINERY.

Works at ERIE, PA.

Having enlarged our Foundry and otherwise added to our facilities, we are prepared to execute orders for castings weighing from a few pounds to *forty tons*. Our Boring and Turning Mill is one of the largest in the United States, by which we can bore and turn a wheel or cylinder up to 30 feet in diameter, and we can plane 30 feet long by almost any width. With our *unsurpassed* means for handling heavy work, and shipping *by boat or rail*, we are enabled to

OFFER INDUCEMENTS

to customers.

We make a specialty of machinery for making Sugar, and furnish everything necessary to fully equip Sugar Refineries or Plantations. Satisfaction guaranteed, and patronage solicited.

S. S. HEPWORTH & CO.,

"Glenwood Station," Yonkers, N. Y.

JOHN McLAREN,

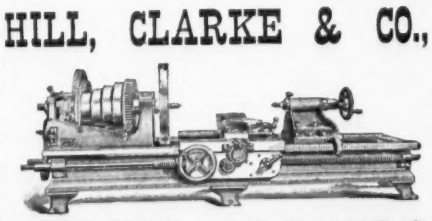
HOBOKEN, N. J.

BUILDER OF

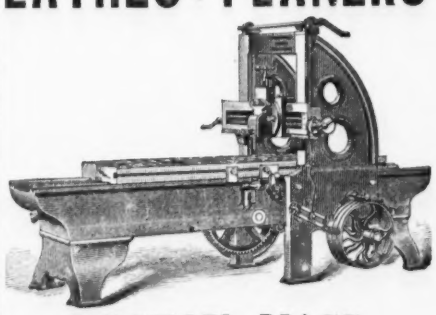
CORLISS ENGINES,

AIR COMPRESSORS AND BOILERS.

HILL, CLARKE & CO.,

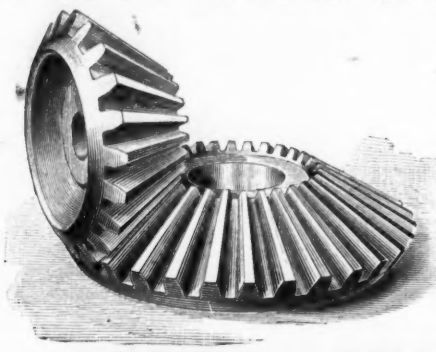


LATHES AND PLANERS



BOSTON, MASS.

ACCURATE BEVEL GEARS.



By the aid of Special Machinery, we are prepared to plane Bevel Gears up to 16 inches diameter, whose ratio is not greater than 4 to 1, with the curves of the teeth theoretically correct.

This method admits of long faces, good contact and smooth running, thereby increasing durability. For patterns to cast from and in places where high speed is required, gears cut in this manner are especially desirable.

BROWN & SHARPE MFG. CO.

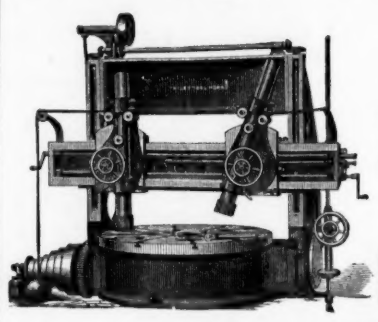
MAKERS OF

Machinery and Tools,

PROVIDENCE, R. I., U. S. A

Boring and Turning Mills,

5, 6, 7, 8, 10, 12, 14 and 16 FT. SWING.



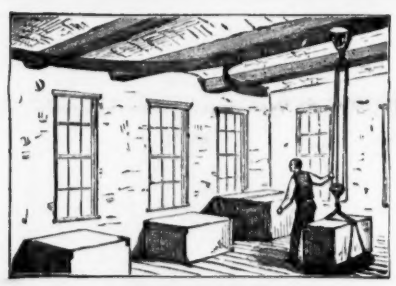
NEW MACHINE,

14–20 ft. Boring and Turning Mill. Housings and upper works arranged to slide back to take in work 20 ft. diameter. Has independent boring and key seating attachment.

NILES TOOL WORKS

Hamilton, Ohio.

NEW YORK, 96 Liberty Street. PHILADELPHIA, 705 Arch St. CHICAGO. 96 Lake Street.



OVERHEAD TRAM-RAILS.

OVERHEAD TRAMRAILS,

—WITH—

Weston's Differential Pulley Blocks,

ANY CAPACITY.

The Weston Pulley Block is suspended from a traveler or trolley which runs freely on the lower flange of the track. The tracks, by means of curves and switches, can reach any desired points. Plans and estimates furnished on application.

SOLE MAKERS,

THE YALE & TOWNE MFG. CO., Stamford, Connecticut.

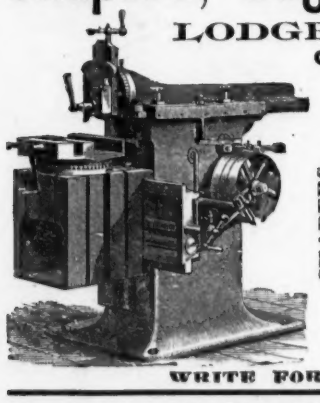
NEW YORK—CHICAGO—PHILADELPHIA—BOSTON.

Catalogues on application.

Shapers, Engine Lathes and Drills.

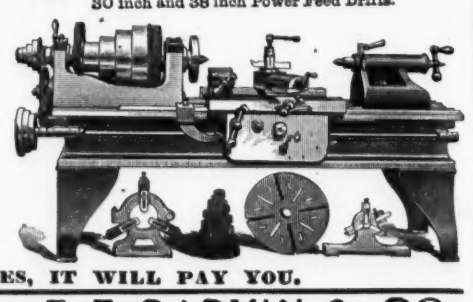
LODGE, DAVIS & CO.,

CINCINNATI, OHIO.



SHAPERS, 6", 8", 10", 20", 26" 32" Stroke.

20 inch Upright Drills. | 26 inch Back Geared and
24 " " " | 30 inch and 38 inch Power Feed Drills.



WRITE FOR PRICES, IT WILL PAY YOU.

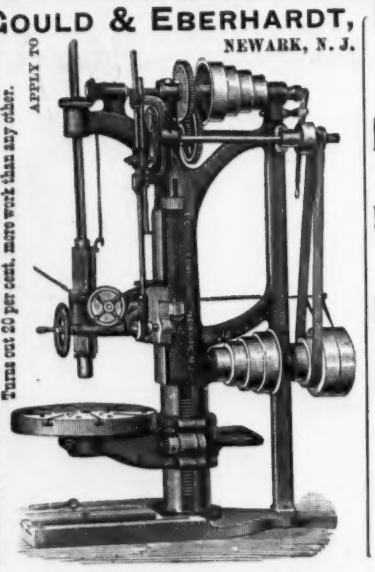
Eberhardt's New Drill

Turns out 20 per cent. more work than any other.

APPLY TO

E. GOULD & EBERHARDT,

NEWARK, N. J.



E. E. GARVIN & CO.,

139 & 141 Centre St., New York,

MANUFACTURERS OF

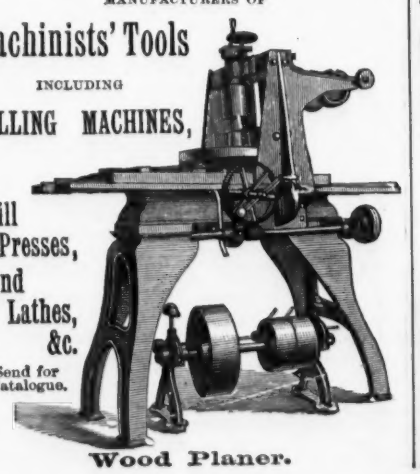
Machinists' Tools

INCLUDING

MILLING MACHINES,

Drill Presses, Hand Lathes, &c.

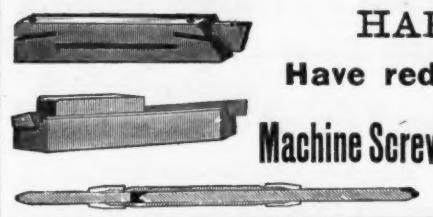
Send for Catalogue.



Wood Planer.

THE PRATT & WHITNEY CO.

HARTFORD, CONN.



Have reduced the Selling Prices

—OF—

Machine Screw Taps & Combination Lathe Chucks.

Now discounting 35 per cent. on each.

THE BILLINGS & SPENCER COMPANY,

HARTFORD, CONN.,

MANUFACTURERS OF

Billings' Improved Combination Pliers,

Drop Forged from Tool Steel.

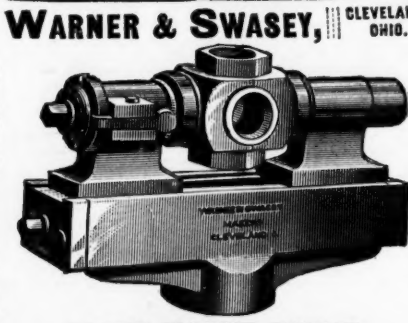
DROP FORGINGS In Copper, Iron or Steel, for Electric Motors and Generators, Guns, Pistols, Sewing Machines,

MACHINISTS' TOOLS AND

Machinery Generally.

Send for Illustrated Catalogue.

WARNER & SWASEY, CLEVELAND, OHIO.



GLOBE VALVE CHUCK.

BRASS WORKING MACHINERY.

ILLUSTRATED CATALOGUE ON APPLICATION.

ENGINE LATHES,

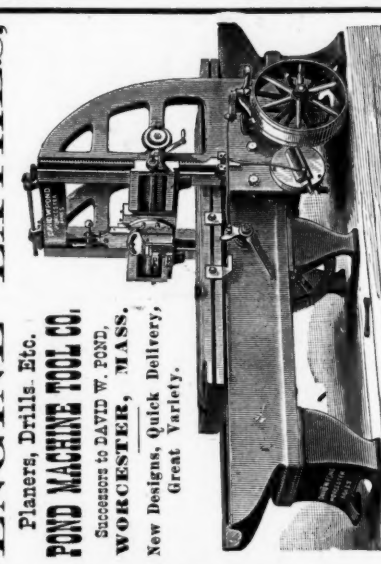
Planers, Drills, Etc.

POND MACHINE TOOL CO.

Successors to DAVID W. POND.

WORCESTER, MASS.

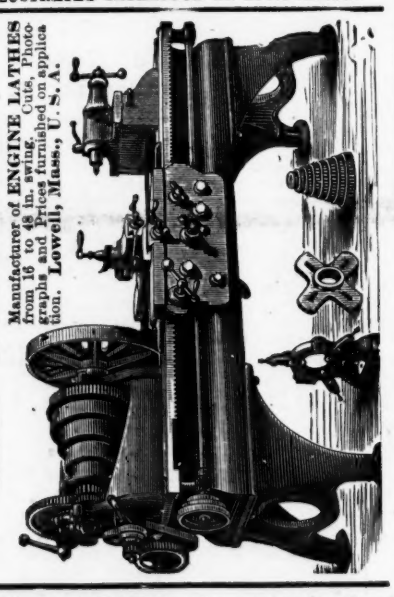
New Designs, Quick Delivery, Great Variety.



Manning, Maxwell & Moore, Sole Selling Agents, 111 Liberty Street, New York.

GEO. W. FIFIELD,

Manufacturer of ENGINE LATHES from 16 to 48 in. swing. Photographs and Prices furnished on application. Lowell, Mass., U. S. A.



BRASS GEARS. I keep in stock a large variety of Cut Gears of Brass and send them post-paid at very low prices.

——SEND FOR MY CATALOGUE——

Geo. B. Grant, 66 Beverly St., Boston, Mass.

KEY SEATING MACHINES

AND

20 in. Drills a specialty.

Our 20 in. Drill is a heavy substantial tool, made for service, has steel shafts and spindle. Gears and racks cut from the solid and have all modern improvements, are made by special machinery, and sold very low.

Our Key Seating Machine will save enough in 60 days' use to pay first cost; no shop can afford to do without one. We have now ready for prompt shipment, both Key Seat Machines and 20 in. Drills. Send for Photo. and Catalogue.

W. P. DAVIS, North Bloomfield, N. Y.

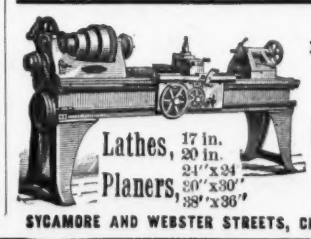
HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.

J. M. ALLEN, PRESIDENT.

W. B. FRANKLIN, VICE-PRESIDENT.

J. B. PIERCE, SECRETARY.



Lathes, 17 in. 20 in. 24"x24"
Planers, 20"x30" 38"x36"

For Prices and Photographs, Write

THE G. A. GRAY CO.

SYCAMORE AND WEBSTER STREETS, CINCINNATI, OHIO.

STEEL CASTINGS.

PRATT & LETCHWORTH, PROPRIETORS

Buffalo Steel Foundry, BUFFALO, N. Y.

PUNCHING PRESSES, DIES,

And other Tools for the Manufacture of all kinds of

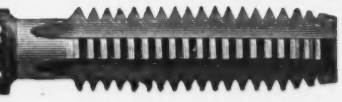
SHEET METAL GOODS, DROP FORGINGS, —ETC.— DROP HAMMERS.

STILES & PARKER PRESS CO.

MIDDLETOWN, CONN.

Branch Office and Factory 203, 205, and 207 CENTRE STREET, NEW YORK.

J. M. CARPENTER PAWTUCKET, R. I.



Manufacturer of TAPS & DIES